JOURNAL

OF THE

ARNOLD ARBORETUM

VOLUME XIII OCTOBER, 1932 NUMBER 4

ENUMERATION OF THE LIGNEOUS PLANTS COLLECTED BY J. F. ROCK ON THE ARNOLD ARBORETUM EXPEDITION TO NORTHWESTERN CHINA AND NORTHEASTERN TIBET

(ADDITIONS AND CONTINUATION)[1]

ALFRED REHDER AND CLARENCE E. KOBUSKI

Page 20 of vol. IX. insert before LILIACEAE:

GNETACEAE

Determined at the Botanical Museum, Berlin-Dahlem

Ephedra monosperma C. A. Meyer, Versuch. Monog. Ephedra, 89, t. 8, fig. 11. (1847).—Stapf in Denkschr. Math.-Nat. Cl. Akad. Wiss. Wien, LVI. pt. 2, p. 73, t. 3, fig. xix. 1–9, xxxi. 3 (Art. Ephedra) (1889)

EASTERN TIBET. Radja and Yellow River gorges: among schist rocky slopes of river valley, west of Radja, alt. 3350 m., no. 13939, May 27, 1926 (plant 5 cm. high; flowers yellow).

LILIACEAE

Page 20 insert before SMILAX TRACHYPODA Nort.:

Smilax Oldhamii Miquel in Versl. Med. Kon. Akad. Weten. ser. 2, II. 86 (1868); in Ann. Mus. Bot. Lugd.-Bat. III. 150 (1868).—Norton in Sargent, Pl. Wilson. III. 9 (1916).

CENTRAL KANSU: Lienhoa shan, no. 13664, Oct. 1925 (climber over bushes; fruit purplish black).

This species does not seem to have been recorded from China before.

Page 22 insert:

SALICACEAE

Populus L.

Determined by ALFRED REHDER

Populus cathayana Rehder in Jour. Arnold Arb. XII. 59 (1931).

SOUTHWESTERN KANSU. Lower Tebbu country: banks

[1] See Vol. IX. 4–27, 37–125 (1928) for preceding parts of this Enumeration.

of Culungapu above Pezhu, no. 14961, Sept.–Oct. 1926 (pyramidal tree with broad crown, 15–18 m., leaf pale green above, grayish beneath).

Populus Simonii Carrière in Rev. Hort. 1867, p. 360.—Rehder in Jour. Arnold Arb. XII. 63 (1931).

Populus Przewalskii Maximowicz in Mél. Biol. XI. 321 (1881); in Bull. Acad. Sci. St. Pétersb. XXVII. 540 (1882).

SOUTHWESTERN KANSU. Tao River basin: Choni, along bank of Tao River, no. 12110, May 1925 (tree 15–18 m., pistillate); mountains of Choni, in forests and on banks of streams, alt. 3000 m., no. 12114, May 1925 (tree 20–24 m., staminate, catkins bright red).

Both specimens are leafless; the pistillate catkins are 2.5–3.5 cm. long with a short-pilose rhachis and short-pedicelled flowers; the ovary is slightly hairy and bears two stigmas.

Photographs representing habit and bark of this species and taken by Rock in January 1926 (no. 12110 according to his notes) are in his collection of photographs. In habit the trees resemble *Populus nigra* L.

Populus nigra Linnaeus, Spec. Pl. 1464 (1753).

NORTHWESTERN KANSU. Richthofen range and adjacent region: Kanchow plain, no. 13325, Nov. 1925 (tree 30 m. or more; trunk white).

I refer this specimen with some doubt to *P. nigra;* the branches are distinctly angular in their upper part, though perfectly terete in their lower third; the leaves are deltoid, truncate at the base, short-acuminate, and of firm subcoriaceous texture, and the bark of the trunk is white according to Rock.

Populus nigra L. var. **italica** Duroi, Harbk. Baumz. II. 141 (1772).

SOUTHWESTERN KANSU. Lower Tebbu country: banks of Peshwekiang, alt. 2000 m., no. 14859, Sept. 14, 1926 (tree 24 m., with ascending branches forming an oval to oblong crown; bark grayish white; leaves dark green above, blue green below).

According to Rock's note the tree has not the columnar habit of the Lombardy Poplar, but the branchlets of the specimen are distinctly adscending and the leaves agree with those of *P. nigra* var. *italica.*

Populus szechuanica Schneid. var. **Rockii,** var. nov.

A typo recedit foliis supra in costa et venis villoso-pilosis et subtus in costa, venis et venulis satis dense et in mesophyllo sparse pilosis.

SOUTHWESTERN KANSU. Lower Tebbu country: Wantsang forests, no. 14846, Sept. 12, 1926 (tree 30 m., trunk 1.25 in.

diam., without branches for 15 or 18 m.; bark drab to grayish brown, longitudinally furrowed; leaf grayish white beneath).

In shape and size of the leaf and in the 3–4-valved capsule the specimen agrees with *P. szechuanica*, but the under side of the leaf is fairly densely pilose on the midrib, veins and veinlets, and also on the upper side the veins are pubescent. In the latter character it resembles *P. Purdomii* Rehd., but that species has 2–3-valved capsules and somewhat narrower leaves glabrous above. It is possible, however, that the sterile specimens from Kagoba, Kansu, referred by me to *P. Purdomii*, belong here.

A picture showing the tall slender trunk of this tree is in the collection of Rock's photographs.

Salix L.[1]

Determined by R. Goerz

Sect. Pentandrae Dumortier

Salix paraplesia Schneider in Sargent, Pl. Wilson. III. 40 (1916).

Eastern Tibet. Radja and Yellow River gorges, with Spruces on northern slopes of valley south of Yellow River, opposite Radja, alt. 3200 m., no. 14111 ♂, June 10, 1926 (shrub to small tree 4.5–6 m.); southwest of Radja, alt. 3200 m., no. 13977 ♀, May 25, 1926 (shrub 2.4–3 m.); above Picea forest, southwest of Radja, alt. 3600 m., no. 13971, May 25, 1926 (shrub 1.2–1.5 m.); opposite Radja, alt. 3500 m., no. 13955 ♂, May 24, 1926 (shrub 1.5–2.4 m., leaf pale green).

Southwestern Szechuan (Muli): mountains of Kulu, alt. 3380 m., no. 17960 ♂, June 1929. (Shrub 1.5 m.)

The chief difference of this species from *S. pentandra* seems to lie in the whitish color of the under side of the leaves, which, however, is less conspicuous on young leaves and often nearly disappears, as on the plant from Szechuan. Other differences indicated by Schneider in his key (in Sargent, Pl. Wilson. III. 74), as size of catkins, number of stamens and length of style are probably less constant and therefore less important.

Sect. Sclerophyllae Schneider

Salix oritrepha Schneider in Sargent, Pl. Wilson. III. 113 (1916).

As Schneider knew only the pistillate plant the description of the staminate catkins may be given here:

Amenta coaetanea, pedunculo brevi 2–5 mm. longo foliis parvis 2–3 normalibus suffulto, ovata, 1–1.5 cm. longa, 0.8–1 cm. crassa,

[1] The Willows collected by Rock in southwestern Szechuan during 1928 and 1929 are included in this enumeration and are distinguished by smaller type.

densiflora; squamae late obovatae, semi-nigrae vel antice purpurascentes, utrinque basi inprimis crispo-villosae, dorso glabrescentes; nectaria 2, angusta, integra vel 2—pluries anguste lobata; stamina 2, filamentis liberis ½ pilosis, antheris ovatis aureis.

EASTERN TIBET. Alpine region between Radja and Jupar Range: alpine meadows of Wajo la, alt. 4200 m., no. 14154 ♂, June 1926 (shrub 60–90 cm.). Jupar Range: among rocks and alpine meadows, upper Jupar valley slopes, alt. 3600–3900 m., nos. 14294 ♂, 14295 ♀, 14296 ♂, 14297 ♀, 14298 ♀, 14299 ♂, 14300 ♀, 14301 ♂, June 1926 (shrub 0.60–1.20 m.); banks of upper Jupar stream, alt. 3600 m., nos. 14352 ♂, 14353 ♀, June 1926 (shrub 1.20–1.80 m.); valley slopes of Kerab, southern slopes of Jupar range, no. 14410 ♂, June 1926 (shrub 0.90–1.20 m.).

CENTRAL KANSU. Lien hoa shan: among rocks, alt. 3500 m. no. 12701 ♀, July 1925 (shrub 0.30–0.60 m.; leaves rich green above, glaucous beneath, male); alpine regions among Rhododendron scrub, alt. 3300 m., no. 12726 ♂, July 1925 (shrub 60–90 cm.; leaves dark green beneath); summit of mountain, alt. 3800 m., no. 13421 (fol.), Nov. 1925 (shrub 1.30 m. or less; semi-prostrate; buds red).

SOUTHWESTERN KANSU. Tao River basin: back of Adjuan, on ridges with Birch, Rhododendron and Spruce, alt. 3200–3300 m., no. 12655 ♀, July 5, 1925 (shrub 0.90–1.50 m.); mountains of Adjüan-Toyüku, Pakeshan, alt. 3000–3300 m., no. 13409 ♀, Nov. 1925 (shrub 1.20 m., forming dense bushes on limestone ridges; leaves pale yellowish beneath); mountains beyond Adjüan, Minshan, alt. 3450 m., no. 13414 (fol.), Nov. 1925 (shrub 0.90–1.20 m.; branches thick, reddish; leaves pale, yellowish beneath).

SOUTHWESTERN SZECHUAN (Muli): Mount Siga, northeast of Kulu, alt. 4600 m., no. 17883 ♂, June 1929 (shrub 60–90 cm.).

Salix oritrepha var. **tibetica** Goerz, var. nov.

Frutex humilis ad 1 m. altus, dense ramosus ramulis tenuioribus brevibus nodosis, foliis julisque minutis.

EASTERN TIBET. Radja and Yellow River gorges: rocky and grassy slopes above Picea forest, northern slopes of Yellow River, southwest of Radja, alt. 3600 m., no. 13969 ♂, May 25, 1926, nos. 13970 ♀, 13972, May 1926 (shrubs 0.60–1.20 m.); alpine meadows between Howa & Arh'tsa canyon, north of Radja, alt. 3450 m., no. 14040 ♂, May 31, 1926 (shrub 90 cm.); north of Radja, alpine slopes of Arh'tsa bluffs, alt. 3300 m., nos. 14053 ♂, 14054, May 31, 1925 (shrub 90 cm.).

SOUTHWESTERN SZECHUAN (Muli): Mount Mitzuga, west of Muli Gomba, alt. 3050–4875 m., no. 16036 ♂, June 1928 (semi-prostrate shrub); Mount Siga, northeast of Kulu, alt. 4300 m., no. 17874 ♀, June 1929 (shrub 0.90–1.20 m.).

Salix muliensis Goerz, spec. nov.

Frutex humilis v. ad 2 m. altus, ramosus ramulis brevibus nodosis, novellis breviter cinereo-tomentosis, postea glabrescentibus vel pilis brevibus obsitis opacis brunneis v. omnino sordide subatris; gemmae semiconicae, adpressae, brunneae, brevi-pilosae. Folia in petiolo 1–3 mm. longo, juvenilia (matura desunt) subtus pilis brevibus acroscopicis adpressis albo-sericeis tecta, dein glabrescentia, glauca, supra venis tantum pilosis mox glabra, atroviridia, elliptica v. obovato-elliptica, antice rotundata, nervis primariis 3–6, margine integro v. tenuissime glanduloso-denticulato; stipulae 0. Amenta (♂ tantum visa) coaetanea in pedunculo 2–3 mm. longo, bracteofoliis squamaceis v. crebrius foliolis normalibus suffulta, subglobosa vel ovata vel brevi-cylindrica, 5–16 mm. longa, 5–8 mm. crassa; squamae obovatae, semi-fuscatae, intus basi crispo-pilosae, dorso glabratae; nectaria bina v. dorsale 0, oblonga, ventrale paulo majus; stamina 2 filamentis liberis ½ pilosis, antheris subglobosis aureis.

SOUTHWESTERN SZECHUAN (Muli): Mount Mitzuga, west of Muli Gomba, alt. 3050–4875 m., no. 16041 ♂ (shrub 2 m.), no. 16079 ♂, (shrub ½ m.), June 1928; Minya Konka Snow Range, south of Tatsienlu, alt. 4600 m., no. 17516 ♂, July 1929 (shrub 30–60 cm.).

This new species is near *S. oritrepha* Schneid., but differs chiefly in the pubescence of the young leaves. *Salix sclerophylla* Anders. from Kashmir shows, as far as I have seen material, a different, more woolly pubescence of the young leaves. The fine serration of the leaves lacking in the two other species, should also be noted.

Salix tenella Schneider in Bot. Gaz. LXIV. 137 (1917).—Handel-Mazzetti, Symb. Sin. VII. 68 (1929).

SOUTHWESTERN SZECHUAN (Muli): Mount Mitzuga, west of Muli Gomba, alt. 3050–4875 m., no. 16035 ♀, June 1928 (shrub 2–3 m.); mountains of Kulu, alt. 4000 m., no. 17964 ♂, no. 17966 ♀, June 1929 (shrubs 1–1.5 m.).

The pubescence of the young leaves is the same in all three numbers and seems typical for the species. While the glaucous under surface is quite glabrous from the beginning or only slightly pubescent at the base, hairs are regularly present on the upper surface, though almost always restricted to the veins. It should also be noted that the young leaves after separation from the tip of the branch remains flat, while in the closely related *S. luctuosa* Lévl. they become strongly revolute at the margin.

Salix luctuosa × **tenella** Goerz, n. hybr.

SOUTHWESTERN SZECHUAN (Muli): Mount Mitzuga, west of Muli Gomba, alt. 3050–4075 m., no. 16074 ♀, June 1928 (shrub 2 m.).

In its fruiting catkins this hybrid closely approaches *S. tenella* Schneid., but differs in its leaves which are strongly revolute along the margin when young and densely short-pubescent beneath. *Salix luctuosa* Lévl. and *S. tenella* seem to grow often together and there can be no doubt that hybrids between the two are not rare.

Sect. ERIOSTACHYAE Schneider

Salix Ernesti Schneider in Sargent, Pl. Wilson. III. 47 (1916).—Handel-Mazzetti, Symb. Sin. VII. 77 (1929).

SOUTHWESTERN KANSU. Tao River basin: ridges of mountains west of Adjüan, alt. 3750 m., no. 12648 ♀, July 1925 (shrub 90 cm.); no. 12649 ♂, July 5, 1925 (shrub 90 cm.).

The pistillate plant also has a dorsal, though very small nectary. The young leaves are strongly revolute and only thinly pubescent and apparently quickly become glabrous.

Salix Balfouriana Schneider in Bot. Gaz. LXIV. 137 (1917).—Handel-Mazzetti in Symb. Sin. VII. 74 (1929).

SOUTHWESTERN SZECHUAN (Muli): Mount Mitzuga, west of Muli Gomba, alt. 3050–4875 m., no. 16070 ♀, June 1928 (tree 5 m.).

Salix plocotricha Schneider in Sargent, Pl. Wilson. III. 49 (1916).

? *Salix spathulifolia* Seemen in Bot. Jahrb. XXVI. Beibl. 82, p. 31 (1905).—Léveillé in Bull. Soc. Bot. France, LVI. 304 (1909).—Handel-Mazzetti, Symb. Sin. VII. 73 (1929).

SOUTHWESTERN KANSU. Tao River basin: along streams, near Adjüan, eastern Minshan, alt. 2700 m., nos. 12640 ♀, 12640a ♀, July 1925 (shrub 1.20–2.40 m.; leaves glaucous beneath); near the head of Maerkhu valley, alt. 3000 m., no. 12960 ♀, July 25, 1925 (tree 4.50–5.40 m.; leaves dark green; petioles and young shoots red; catkins reddish); near Tebbu, Shimen to Drjakana, alt. 3150 m., no. 13190 ♀, August 1925 (tree or shrub 1.80–3 m.; catkins long, greenish); Toyüku valley, slopes of Pakeshan, Minshan range, alt. 3000 m., no. 13410 (fol.), Nov. 1925 (shrub 4.50 m., branches slender; leaves dull beneath); beyond Adjüan, in forests along stream, alt. 3000 m., no. 13412 (fol.), Nov. 1925 (shrub or small tree 4.50–6 m., branches straw-colored); along banks of stream below Mt. Kuang kei, Kadjaku, Minshan, alt. 2850 m., no. 13415 (fol.), Nov. 1925 (shrub 1.80–3 m., branches ascending). Upper Tebbu country: along Kaichow stream not far from its source, south of the Minshan, alt. 3000 m., no. 12486 ♀, June 1925 (shrub 1.80–2.40 m.; leaf whitish below).

CENTRAL KANSU. Lien hoa shan: in Spruce forests and outskirts, alt. 3000 m., no. 12729 ♀, July 1925 (shrub 3 m., leaves glaucous beneath).

I was unable to decide whether Seemen's species is identical with *S. plocotricha*, since I could not examine the original. A close connection exists doubtless between the three species of the section Eriostachyae enumerated above. *Salix Ernesti* is distinguished from the other species chiefly by the presence of a second gland in the pistillate flower, a character which is not supposed to be constant. The specimens cited above for *S. Balfouriana* and *S. Ernesti* are very similar in the development of the leaves which are strongly revolute at first, but differ much in their pubescence, while in *S. plocotricha* the young leaves are flat and floccose-tomentose. Again similar to this is *S. Delavayana* Hand.-Mazz. which, however, has a glabrous ovary.

Sect. DENTICULATAE Schneider

Salix denticulata Andersson in Svensk. Akad. Hand. 1850, p. 481 (1851).—Klotzsch & Garcke, Bot. Ergeb. Reise Prinz. Waldemar, 119, t. 89 (1862).—Schneider in Sargent, Pl. Wilson. III. 117 (1916).

SOUTHWESTERN KANSU. Tao River basin: along lateral streams, Tao watershed, alt. 3000 m., no. 12237 ♂, June 1925 (shrub 1.80–3 m.; flowers yellow); along streams south of Minshan below Shimen, alt. 3000 m., no. 12484 ♂, June 1925 (shrub 1.50–2.40 m.).

Though this species originally described from the Himalayas has not yet been recorded from China, I have no doubt in its correct identification. The only difference would be the pubescence of the floral bracts which are described by Andersson as "obsolete puberulae," while they are on the Kansu specimens rather evenly short-pubescent. The two specimens though collected in different localities are very similar; in no. 12237 both nectaries are rather deeply divided into two narrow lobes.

Sect. LONGIFLORAE Schneider

Salix tibetica Goerz, spec. nov.

Frutex vel arbor ad 4.5 m. altus, ramulis novellis pubescentibus, anniculis omnino glabrescentibus, cortice gemmisque fuscis subinde parum pruinosis. Folia in petiolo puberulo 4–6 mm. longo, novella plana, utrinque glabra, costa supra brevi-tomentosiuscula subtusque parce pilosa excepta, adulta ovata vel ovato-elliptica, ca. (1:1¾) 3–4.5 cm. longa, basi rotundata, apice brevi vel triangulari, supra viridia, subtus glauca vel albida, margine sat dense crenato-dentata; stipulae 0 vel minutae, ovatae, deciduae. Amenta coaetanea, in pedunculo 2–6 mm. longo foliolis parvis 2–3 saepe caducis instructo, ♂ ovata, 1–1.5 cm. longa, 0.8 cm. crassa, densiflora, rhachi albo-pilosa; squamae ovatae, semifuscae, utrinque omnino basi crispo-pilosae; nectarium singulum ovale; stamina 2, filamentis liberis ⅓ pilosis 4–5 mm. longis, antheris ovalibus aureis. Amenta fructifera crasse cylindrica, densiflora, ca. 3 cm. longa, 1 cm. crassa, rhachi squamisque ut in ♂; nectarium singulum oblongum pedicellum glabrum 0.3–0.5 mm. longum subaequans; capsula glabra, ca. 4 mm. longa, stylo ca. 1 mm. longo stigmatibus 0.5 mm. longis bilaciniatis coronato.

EASTERN TIBET. Jupar Range: Jupar streambed, alt. 3150 m., no. 14304 ♂, June 1926 (tree 3.5–4.5 m.); Jupar valley along streambed, alt. 3150 m., no. 14284 ♀, June 1926 (shrub to tree 4.5 m.).

Salix juparica Goerz, spec. nov.

Frutex altus vel arbor ad 4.5 m. alta, ramulis tenuibus, novellis pubescentibus vel subglabris, demum omnino glabris, anniculis brunneis vel fuscis. Folia recentissima plana, subtus ab initio plus minusve glabra, supra dense pilosa cito glabrescentia, costa puber-

ula excepta, adulta in petiolo puberulo 2–4 mm. longo, elliptica (ca. 1.2) vel apicalia sublanceolata (1:2½–3) 3–4 cm. longa, utroque plus minusve aequaliter angustata, supra atroviridia, subtus glauca vel albido-glauca, margine crenulato vel interdum subintegro; stipulae 0 vel minutae, caducae. Amenta coaetanea, in pedunculo 0.4–0.8 cm. longo foliolis parvis vel squamaceis 2–3 instructo, ♂ cylindrica, ca. 2 cm. longa, 4–5 mm. crassa, densiflora, rhachi pilosa; squamae obovatae, pallidae, brevipilosae, ca. 1 mm. longae; nectarium singulum, oblongum; stamina filamentis 2 liberis ½ pilosis ca. 3 mm. longis, antheris subglobosis aureis. Amenta ♀ crasse cylindrica, ad 2.5 cm. longa, 9 mm. crassa, densiflora, fructifera ad 6 cm. longa, rhachi pilosa; squamae obovatae, semifuscae, puberulae, ca. 1 mm. longae; nectarium singulum oblongum, pedicellum ½ mm. longum plus minusve aequans; germen cinereo-pilosum ca. 5 mm. longum in stylum 0.5 mm. longum paulatim attenuatum, stigmatibus 0.5 mm. longis bilobatis plus minusve conniventibus.

EASTERN TIBET. Jupar Range: Jupar streambed, alt. 3150 m., no. 14303 ♀, June 1926 (tree 3.6–4.5 m.); Jupar valley along streambed, alt. 3150 m., no. 14283 ♀, June 1926 (tree 4.5 m.). Radja and Yellow River gorges: in streambed at Dachso canyon, north of Radja, alt. 3150 m., no. 14085 ♀, June 2 1926 (shrub 3–4.5 m.); northern slopes of river valley mountains opposite Radja, alt. 3150 m., no. 14001 ♂, May 27, 1926 (shrub 2.40–3 m.).

The specific differences between *S. juparica* and *S. tibetica* are not yet quite clear. The pistillate specimen of *S. tibetica* differs in the oval leaves and the glabrous capsules from the pistillate *S. juparica*. The staminate *S. tibetica* (no. 14304), however, also resembles *S. juparica* (no. 14303), together with which it apparently had been collected. It is not impossible that the latter is a hybrid. Further material is needed to arrive at a clear understanding.

Salix hypoleuca Seemen var. **kansuensis** Goerz, var. nov.

Differt a typo foliis subtus pallide viridibus (non glaucis), pedunculis foliis normalibus ceteris paulo minoribus instructo.

SOUTHWESTERN KANSU. Upper Tebbu country: south of Minshan range, along streams, alt. 2900 m., no. 12440 ♂, June 1925 (shrub or small tree 4.5 m.; catkins yellow); south of Minshan range near Tongwa, along streams, alt. 2900 m., no. 12441 ♀, June 1925 (shrub 1.80–2.40 m.); southern slopes of Minshan, along bank of mountain stream, alt. 3200 m., no. 12500 ♀, June 1925 (shrub 1.20–1.80 m.).

Salix Rockii Goerz, spec. nov.

Frutex ad 3 m. altus, ramulis sat longis saepe divaricatis, novellis pubescentibus, anniculis omnino glabris brunneis saepe subnitentibus; gemmae semiconicae, acutae, glabrae, nitidae. Folia juvenilia plana, subtus pilis longis acroscopicis sparse, supra pilis brevibus sparsissime obsita, mox glabra, subtus pallida vel subalbida, elliptica, ca. 1.5 cm. longa, margine minute denticulata, petiolo 1–2 mm. longo puberulo; folia matura desunt; stipulae 0. Amenta coaetanea, in pedunculo brevissimo 2 vel 3 foliolis vulgo sat magnis instructo, ♂ ovato-cylindrica, 2 cm. longa, 1 cm. crassa, densiflora, rhachi pilosa; squamae obovatae antice fuscatae, longe albo-barbatae; nectarium singulum (vel dorsale minutum) rectangulum; stamina 2 filamentis liberis ½ pilosis. Amenta ♀ crasse-cylindrica, 1.5–2 cm. longa, 8 mm. crassa, rhachi et squamis ut in ♂; squamae interdum pallidae; nectarium rectangulum pedicellum brevissimum subaequans; germen anguste conicum, 2 mm. longum, griseo-pilosum vel albo-tomentosum, in stylum 1 mm. longum fuscum attenuatum, stigmatibus 0.4 mm. longis plus minusve divisis divaricatis.

Eastern Tibet. Radja and Yellow River gorges: Radja gomba, on rocky cliffs with Junipers, alt. 3300 m., nos. 13928 ♂ and 13929 ♂, May 20, 1926 (shrub 2.40–3 m.); valley of Nyavruch north of Radja, lateral valley, along streambed, no. 13931 ♀, May 27, 1926 (shrub 1.20–1.80 m.); with Willows on rocky and grassy slopes above Yellow River gorge, alt. 3300 m., no. 13943 ♀, May 27, 1926 (shrub 1–1.20 m.); valley of Nyavruch northwest of Radja, and rocky streambed, alt. 3300 m., no. 13944 ♂, May 27, 1926 (shrub 2.40–3 m.); among spruce forest southwest of Yellow river opposite Radja, alt. 3450 m., no. 13957 ♀, May 24, 1926 (shrub 1.80 m.); same locality, alt. 3300 m., no. 13959 ♂, May 24, 1926 (shrub 2.40–3 m.).

This species resembles in its floral characters *S. oritrepha* Schneid., but differs clearly in its nectaries and in the finely serrate leaves.

Salix cereifolia Goerz, spec. nov.

Frutex ad 1.80 m. altus, ramulis sat tenuibus brevibus divaricatis, novellis sparse pubescentibus, anniculis glabris brunneis opacis vel sat nitentibus; gemmae glabrae, brunneae. Folia novella (adulta desunt) in petiolo brevi, plana, oblonga, utroque aequaliter angustata, ca. 1.5 cm. longa, utrinque glabra, supra viridia, subtus cereo obducto glauca, integra; stipulae 0. Amenta coaetanea, ♂ subsessilia, bracteofoliis squamaceis deciduis suffulta, anguste cylindrica, 1.5–2 cm. longa, 0.5 cm. crassa, densiflora, rhachi brevipilosa; squamae obovatae, pallidae, subglabrae; nectarium 1,

minutum, ovale; stamina 2, filamentis liberis glabris ca. 2 mm. longis squamas haud multo superantibus, antheris ovalibus aureis. Amenta ♀ tantum statu maxime juvenili adsunt, 5 mm. longa, simili figura ut in ♂ videntur; squamae glabrae, pallidae; nectarium 1, germen sessile, breviconicum, glabrum, stylo stigmatibusque brevibus.

SOUTHWESTERN KANSU. Tao River basin: mountains of Choni, in forests and banks of streams, alt. 3000 m., no. 12115 ♀, May 1925 (shrub 1.50–1.80 m.); mountains of Choni, alt. 2700 m., no. 12123 ♂, May 1925 (shrub 1.50–1.80 m.).

Resembles in its habit *S. tenella* Schneid., but differs in the staminate flowers having only one nectary and in the leaves being glabrous from the beginning.

Sect. DIPLODICTYAE Schneider

Salix Faxoniana Schneider in Bot. Gaz. LXIV. 143 (1917).—Handel-Mazzetti in Symb. Sin. VII. 82 (1929).

SOUTHWESTERN SZECHUAN (Muli): alpine meadows, Mount Mitzuga, west of Muli Gomba, alt. 4000 m., no. 16054 ♂, June 1928 (shrub 1 m.), mountains of Kulu, in gravelly streambed, alt. 4150 m., no. 17951 ♂, June 1929 (prostrate shrub).

The plants agree well with the male type of the species (Rock no. 4473) described by Handel-Mazzetti (l. c.).

Sect. BERBERIFOLIAE Schneider

Salix flabellaris Andersson in Svensk. Vetensk. Akad. Handl. 1850, p. 497 (1851); in Jour. Linn. Soc. IV. 54 (1860); in De Candolle, Prodr. XVI. pt. II. 295 (1868).—Schneider in Sargent, Pl. Wilson. III. 142 (1916).

SOUTHWESTERN KANSU. Upper Tebbu country: foot of Shimen, alt. 3600 m., no. 13059 ♀, July–August 1925 (prostrate shrub covering boulders and grassy slopes; catkins green).

SOUTHWESTERN SZECHUAN: Mount Konka, Risonquemba, Konkaling, alt. 3690–5335 m., no. 16869 ♀, June–August 1928 (prostrate shrub).

Salix flabellaris f. spathulata Andersson, l. c.

SOUTHWESTERN KANSU. Upper Tebbu country: foot of Shimen, alt. 3600 m., no. 13058 ♀, July–August 1925 (prostrate shrub growing perfectly flat, covering boulders and grassy slopes; catkins red).

Sect. LINDLEYANAE Schneider

Salix Lindleyana Wallich apud Andersson in Svensk. Vetensk. Akad. Handl. 1850, p. 499 (1851); in Jour. Linn. Soc. IV. 56 (1860); in De Candolle, Prodr. XVI. pt. II. 296 (1868).—Schneider in Sargent, Pl. Wilson. III. 145 (1916).

Salix Souliei Seemen in Fedde, Rep. Spec. Nov. III. 23 (1906).—Schneider in Sargent, Pl. Wilson. III. 62 (1916).

SOUTHWESTERN SZECHUAN (Muli): Mount Mitzuga, west of Muli Gomba, alt. 3050–4875 m., no. 16567 ♂, June 1928 (prostrate shrub); Minya Konka Snow Range, south of Tatsienlu, alt. 4660 m., no. 17529 ♂, July 1929 (prostrate shrub).

This apparently very polymorphous species is best to be compared with the European *S. retusa* L. The delimitation of the species united by Schneider under the section Lindleyanae is mostly rather uncertain and apparently further reductions will be necessary; shape and size of leaf, its margin and color of the under surface are often very variable in the same species, as it is the case in *S. retusa*.

Sect. GLAUCAE Fries

Salix opsimantha Schneider in Sargent, Pl. Wilson. III. 63 (1916).

SOUTHWESTERN SZECHUAN: Chiu-Lung-Hsien Territory, east of the Yalung River, alt. 3080 m., no. 16435 ♂, May 1929 (tree 3–5 m.; fls. rich pink with purplish tinge).

The plant agrees very well with Schneider's description. It resembles *S. Faxoniana*, as already stated by Handel-Mazzetti (Symb. Sin. VII. 82) but is readily distinguished by its tall habit, even tree-like in the specimen cited above.

Salix Ernesti × opsimantha Goerz, hybr. nov.

SOUTHWESTERN SZECHUAN: Mount Konka, Risonquemba, Konkaling, alt. 3960–5335 m., no. 16833 ♀, August 1928 (shrub 3–4 m.); Muli, mountains of Kulu, east of Muli Gomba, alt. 3650–4425 m., no. 16437 ♀, June 1928 (shrub 60–90 cm.).

No. 16833 differs from *S. opsimantha* Schneid. which it resembles according to Schneider's description, chiefly in the crenate leaves, the two nectaries (the ventral one twice as long as the dorsal one), entire or parted and in the tomentose fruit. The two latter characters indicate *S. Ernesti* as the second parent. No. 16437 is still closer to *S. opsimantha*, since it has only one long nectary and the ovary only slightly pubescent above the middle.

Salix pseudospissa Goerz, spec. nov.

Frutex 0.90–1.50 m. altus, ramulis brevibus crassis nodosis, novellis ab initio glabris, anniculis fuscis vel sordidis; gemmae semiconicae, adpressae, acutatae, argute carinatae, glaberrimae, fuscae. Folia in petiolo 3–6 mm. longo glabro, novella utrinque glaberrima (costa inclusa), plana, adulta obovata 3–5 cm. longa, apice brevi, basi rotundata, nervis primariis 8–10, reticulo utrinque obsolete elevato, supra atroviridia, subadiposa, subtus albida, margine anguste denticulato; stipulae 0. Amenta coaetanea, brevipedunculata, foliis 2–3 normalibus parvis suffulta, percrasse cylindrica, ad 3 × 1 cm. (fructu ad 5 cm.), rhachi crassa parce pilosa; squamae magnae (ad 2 × 6 mm.), obovatae, fuscae, venulosae, utrinque brevissime crispo-pilosae, dorso glabrescentes; nectarium singulum, oblongum, 0.6 mm. longum; stamina 2, ca. 12 mm. longa, filamentis liberis ½ pilosis, antheris ovatis flavidis. Amenta ♀ rhachi et squamis ut in ♂, squamis ex parte latioribus (3 mm.) antice saepe crenulatis; nectaria singula vel bina, ventrale ampullaceum, ad 0.8 mm., dorsale 0.5 mm. longum; pedicellus brevissimus nectarium dorsale aequans; germen anguste conicum, 3–4 mm. longum, squama occul-

tatum, subrufo-tomentosum, in stylum fuscum plus minusve 1.5 mm. longum maxima ex parte fissum attenuatum, stigmatibus 0.6 mm. longis bipartitis laciniis filiformibus erecto-patentibus.

SOUTHWESTERN KANSU. Tao River basin: Mt. Kuang ke shan, along mountain torrents, alt. 3600 m., no. 12362 ♀, June 1925 (shrub 1.2–1.5 m., catkins rich yellow); Minshan range, below pass of Mt. Kuang kei, alt. 3600 m., no. 12410 ♂, June 1925 (shrub 1.2 m. or less; flowers and catkins a rich yellow); Mt. Kuang Kei, trail to Djrakana, Minshan, among Rhododendron, alt. 3750 m., no. 13414 (fol.), Nov. 1925 (shrub 1.2–1.5 m.; branches stiff, thick; leaves pale beneath).

CENTRAL KANSU. Lien hoa shan: alpine regions; alt. 3300 m., no. 12725, July 1925 (shrub 1.5 m., leaves glaucous beneath).

This species differs from *S. spissa* Anderss. found in the Tienshan and Altai Mountains chiefly in the large less pubescent floral bracts and the partly double nectary. It is to be expected that occasionally also in the staminate flower a dorsal nectary may occur. Also the very close serrature and the perfectly glabrous branches of leaves should be noted.

Salix Delavayana Handel-Mazzetti in Symb. Sin. VII. 78 (1929).

SOUTHWESTERN SZECHUAN (Muli): mountains south of Muli, Mount Gibboh, alt. 3050–3960 m., no. 17238 ♂, May 1928 (shrub 2–3 m.); mountains of Kulu; alt. 4000–4300 m., no. 17952 ♂, no. 17953 ♀, no. 17965 ♂, no. 18095 ♂, June–July 1929 (shrub 0.60–1.50 m.).

Those numbers in which the catkins and leaves are just expanding, show much resemblance to *S. spodiophylla* Hand.-Mazz. (op. cit. 77), which is possibly a hybrid with *S. Delavayana* as one of the parents.

Sect. CAPREAE Dumortier

Salix Wallichiana Andersson in Svensk. Vetensk. Akad. Handl. 1850, p. 477 (1851); in Jour. Linn. Soc. IV. 50 (1860); in Svensk. Vetensk. Akad. Handl. IV. 80, tab. 5, fig. 46 (Monog. Salic.) (1867); in De Candolle, Prodr. XVI. pt. II. 223 (1868).—Schneider in Sargent, Pl. Wilson. III. 64 (1916).—Handel-Mazzetti, Symb. Sin. VII. 87 (1929).

SOUTHERN KANSU: mountains of Pikou and Mosuping, alt. 1200 m., no. 12066 ♂, April 1925 (shrub 1.5–1.8 m.).

SOUTHWESTERN KANSU. Tao River basin: mountains of Choni, west of Tao river, Picea forest, alt. 3000–3150 m., no. 12125 ♀, no. 12126 ♂, no. 12128 ♂, May 1925 (tree 4.50–5.40 m.); Choni, banks of mountain streams west of Taoho, alt. 2850 m., no. 12135 ♀, May 1925 (shrub 1.5 m.); mountains west of Choni, alt. 3000 m., no. 12136 ♂, May 1925 (shrub or small tree 4.5 m.); along banks of Choni river, near bridge, alt. 2520 m., no. 12305 ♀, June 1925 (tree 4.5–6 m., often shrubby).

Western Szechuan: above Ching chuan mountains along stream, alt. 1800 m., nos. 12045 ♀, no. 12047 ♂, no. 12048 ♂, April 1925 (tree or shrub 1.80–3 m.).

Salix pseudo-Wallichiana Goerz, spec. nov.

Frutex excelsus vel arbor ad 6 m. alta, ramulis sat tenuibus novellis pubescentibus vel albo-villosulis, anniculis, subglabris brunneis vel fuscis; gemmae conicae, brunneae, glabrae. Folia in petiolo puberulo 4–6 mm. longo, utrinque pilis brevibus adpressis sparse obducta, plana, adulta glabra vel costa puberula, late ovato-elliptica, apice brevi (1:1½–2), apicalia ovato- vel obovato-lanceolata, apice subproducto (ca. 1:3), 3–5 cm. longa, supra opaco-viridia, subtus glauca, nervis primariis 7–10, reticulo vix conspicuo subtus parum elevato, margine integro vel in foliis apicalibus irregulariter dentato. Stipulae 0 vel parvae, semicordatae. Amenta coaetanea vel subcoaetanea in pedunculo brevissimo vel in ♀ ad 7 mm. longo, bracteis squamaceis caducis suffulta, ♂ ovata, ca. 2 cm. longa, 1.5 cm. crassa, densiflora, rhachi pilosa; squamae anguste obovatae, ca. 0.6 × 1.8 mm., antice subatrae, longe albo-barbatae; nectarium oblongum, 0.5 mm. longum; stamina filamentis 2 liberis ½ pilosis, 6 mm. longis, antheris ovalibus aureis. Amenta ♀ crasse cylindrica, ad 3.5 cm. longa, 1.5 cm. crassa, densiflora; squamae et nectarium ut in ♂; pedicellus nectarium aequans vel triplo superans, pilosus; germen anguste conicum, 4.5 mm. longum, stylo 0.4–0.6 mm. longo, stigmatibus 0.6 mm. longis, divisis, laciniis tenuibus, patentibus. Valvae capsulae post dehiscentiam parum recurvatae.

Eastern Tibet. Grasslands between Labrang and Yellow River: in Serchen leading to Yellow River between Dzangar and Radja Gomba, no. 13917 ♂, May 15, 1926 (shrub 3–4.5 m., flowers golden yellow). Jupar Range: streambed of Jupar valley, alt. 3150 m., no. 14287 ♀, June 1926 (tree 4.5–6 m.). Radja and Yellow River gorges: along streambed and outskirts of spruce forest in Dachso Canyon, north of Radja, alt. 3150 m., no. 14077 ♀, June 2, 1926 (shrub 3 m.).

The catkins and all parts of the flower are more graceful than in *S. Wallichiana* Anderss., the filaments are pubescent, the pedicel short or very short, the style longer and the leaves broader. The latter resemble much the type of *S. livida* Wahlbg. which, however, has very long pedicels. One could almost take these plants for hybrids of *S. Wallichiana* with *S. Rockii* Goerz, but the former has not been collected in Eastern Tibet by Rock or by any one else.

Sect. Incubaceae Dumortier

Salix sibirica Pallas, Fl. Ross. I. pt. II. 72, t. 81, fig. 3 (1788).—Schneider in Sargent, Pl. Wilson. III. 154 (1916).

EASTERN TIBET. Radja and Yellow River gorges: valley of Nyavruch north of Radja, lateral valley, along rocky streambed, no. 13932 ♂, May 27, 1926 (shrub 1.8–2.4 m.).

SOUTHERN KANSU: mountains of Motzuping and Pikou, along stream, no. 12071 ♂, April 1925 (shrub 1.2 m.).

SOUTHWESTERN KANSU. Tao River basin: Minshan range, ravines of Kadjaku, alt. 3150 m., no. 12379 ♂, June 1925 (shrub 2.4–3 m.); Minshan range, slopes of Kadjaku valley below Kuang ke, alt. 3000 m., no. 12420 ♂, June 1925 (shrub 3 m.; catkins yellow).

CENTRAL KANSU. Lien hoa shan: swampy alpine meadows, alt. 2850–3000 m., no. 12685 ♀, July 14–20, 1925 (shrub 60–90 cm., often 30 cm.; leaves silvery), no. 13420 (fol.), Nov. 1925 (shrub 1.2–1.8 m.; leaves silvery tomentose on both sides).

Salix sibirica is new for China; the specimens, however, are not all typical. Very characteristic is the pistillate plant from central Kansu which could even be taken for the European *S. repens* L., if it had longer pedicels. On account of its short pedicels it belongs to var. *subsessilis* (Regel) Goerz (*S. repens* var. *subsessilis* Regel). The two numbers from southwestern Kansu recall forms from the Pamir which constitute a distinct species (*S. schugnanica* Goerz, adhuc ined.), but are not identical with it. Owing to the lack of fully grown leaves a definite conclusion cannot be reached. The filaments are glabrous in all numbers.

Salix juparica × **sibirica** Goerz, hybr. nov.

EASTERN TIBET. Radja and Yellow River gorges: valley of Nyavruch north of Radja, lateral valley, along rocky streambed, no. 13933 ♂, May 1926 (shrub 3–4.5 m. branching from base; flowers yellow).

This hybrid was found at the locality cited with both parents. It resembles *S. sibirica* Pall., but differs in the somewhat slenderer catkins, the slightly pubescent filaments and in the scarcely pubescent unfolding leaves.

Sect. VIMINALES Bluff & Fingerhuth

Salix Rehderiana Schneider in Sargent, Pl. Wilson. III. 66 (1916).

SOUTHERN KANSU: mountains between Motzuping and Pikou, along streambeds, no 12070 ♀, April 1925 (shrub 1.5–1.8 m.).

The catkins of the specimen are still very young, but according to the floral characters (pedicel and ovary glabrous; style long, stigmas short, pedicel very short) it can hardly be referred to any other species.

Salix Rehderiana Schneid. var. **brevisericea** Schneider l. c. 67.

EASTERN TIBET. Grasslands between Labrang and Yellow River: Gochen valley near mouth at Yellow River gorge south of Dzang lamassery, alt. 3060 m., (?) no. 13912 ♀, May 14, 1926 (shrub 1.6–2.4 m.). Radja and Yellow River gorges: rocky slopes back of Radja, alt. 3300 m., (?) no. 13925 ♂, May 20, 1926 (shrub 1.6–2.4 m.); valley of Nyavruch north of Radja, lateral valley, along rocky streambeds, no. 13934 ♀, May 27, 1926 (shrub 2.4–3 m.). Jupar Range: Jupar streambed, alt. 3150 m., nos. 14305 ♀, and 14306 ♂, June 1926 (tree 3–4.5 m.); along streambed in upper Jupar valley, alt. 3600 m., no. 14350 ♀, June 1926 (shrub 3–3.6 m.).

SOUTHWESTERN KANSU. Upper Tebbu country: along banks of mountain streams, southern slopes of Minshan, alt. 3180 m., no. 12501 ♀, June 1925 (shrub 1.8–2.4 m.). Tao River basin: forests of Shiaoku, among Larches, Birches, Spruce, alt. 3000 m., no. 12816 ♀, July 1925 (shrub 2.4–3.6 m.). Lower Tebbu country: along stream of Mayaku in Abies forest, alt. 3000 m., no. 14962 (fol.), Oct. 1926 (shrub 3–4.5 m., with ascending branches; leaf dull green above, pale beneath).

CENTRAL KANSU. Lien hoa shan: among alpine scrub and on edge of forests, alt. 3450 m., no. 12785 ♀, July 1925 (shrub 1.2 m.); same locality alt. 2850 m., no. 13419 (fol.), Nov. 1925 (shrub 1.8–2.4 m., branches blackish; leaves dark green, glossy above, glaucous beneath).

The variety with pubescent ovary seems to be the most common in the region. No. 13934 resembles very much the plant distributed under no. 644 by Toepffer in his Salices exsiccatae. I cannot see any evidence of a relationship between var. *brevisericea* and *S. myrtillacea*, as suggested by Schneider (l. c.). Nevertheless one of the two forms, the one with glabrous or the one with pubescent ovary may turn out to be a hybrid. No. 13925 has its buds just opening and therefore its identification is not quite certain. No. 13925 may possibly be a hybrid of *S. Rehderiana* and × *S. taoensis* Goerz as the thicker very precocious catkins suggest.

Sect. HELIX Dumortier

Salix Wilhelmsiana Marshall von Bieberstein, Fl. Taur.-Caus. III. Suppl. 627 (1819).—Schneider in Sargent, Pl. Wilson. III. 169. (1916).—Fedtschenko, Consp. Fl. Turk. VI. 326. (1916).—Goerz in Grossheim, Fl. Kauk. II. 10 (1930); in Fedde, Rep. Spec. Nov. XXVIII. 129 (1930); Salic. Asiat. I. 16, no. 17 (1931).

Salix angustifolia Willdenow, Sp. Pl. IV. 699. (1805).—Stschégléew in Bull. Soc. Nat. Moscou, XXVII. pt. I. 196 (1854).—Boissier, Fl. Orient. IV. 1187 (1879).

Salix angustifolia var. *eriocarpa* Ledebour, Fl. Ross. III. 604 (1850).
Salix dracunculifolia Boissier in Kotschy, Pl. Pers. austr. no. 621; Diagn. I. 99 (1846).—Boissier et Buhse, Herb. Pers. I. 201, sec. Andersson.—Trautvetter in Act. Hort. Petrop. IX. 176 (1884).

EASTERN TIBET. Radja and Yellow River gorges: valley of Nyavruch, north of Radja, lateral valley, along streambed, nos. 13936 ♀ and 13937 ♂, May 27, 1926 (shrub 1.20 m.); north of Radja, Yellow River valley, alt. 3150 m., nos. 14031 ♀ and 14032 ♂, May 28, 1926 (shrub 1.20–1.80 m.). Ba valley: along stream, alt. 3000 m., no. 14262 ♀, June 1926.

SOUTHWESTERN KANSU. Tao River basin: Choni, banks of Tao river, alt. 2460 m., no. 12107 ♂, May 1925.

The specimen from Tibet agrees with the type of the species, only 13936 has somewhat longer styles, possibly due to the influence of *S. myrtillacea*. The specimen from Kansu is not yet sufficiently developed but seems to belong also to the type.

Salix cheilophila Schneider in Sargent, Pl. Wilson. III. 69 (1916).—Handel-Mazzetti, Symb. Sin. VII. 87 (1929).

SOUTHWESTERN SZECHUAN (Muli): Muli and Litang River valley, near Muli Gomba, alt. 2600–3000 m., no. 16119 ♀, May 1928 (shrub or small tree).

Salix myrtillacea Andersson in Jour. Linn. Soc. IV. 51 (1860).—Schneider in Sargent, Pl. Wilson. III. 71 (1916).—Handel-Mazzetti in Symb. Sin. VII. 89 (1929).

Salix subpycnostachya Burkill in Jour. Linn. Soc. XXVI. 532 (1899).—Léveillé in Bull. Soc. Bot. France, LVI. 301 (1909).
Salix squarrosa Schneider in Bot. Gaz. LXIV. 142 (1917).

EASTERN TIBET. Radja and Yellow River gorges: rocky slopes back of Radja, alt. 3300 m., no. 13927 ♂, May 20, 1927 (shrub 1.80–2.40 m.); rocky and grassy slopes above Picea forest, northern slopes Yellow River southwest of Radja, alt. 3600 m., no. 13967 ♂, May 25, 1926 (shrub 0.60–1 m.); alpine regions south of river, opposite Radja, alt. 3600 m., no. 13997 ♀, May 27, 1926 (shrub 1–1.2 m.); valley of Nyavruch north of Radja, alt. 3300 m., no. 14039 ♂, May 31, 1926 (shrub 1.20–1.50 m.).

SOUTHWESTERN KANSU. Tao River basin: mountains west of Choni, alt. 3000 m., no. 12137 ♂, May 1925 (shrub 60–90 cm.; flowers red as is the whole plant); Minshan range, southwest of Choni on slopes and alpine meadows, alt. 3300 m., no. 12359 ♂, June 1925 (shrub 0.90–1.20 m.; catkins grey); ravines of Kwadjaku, alt. 3150 m., no. 12378 ♀, June 1925 (shrub 1.50–1.80 m.); along river, near Choni, no. 13402 (fol.), Nov. 1925 (shrub or small tree 2.10–3 m.); valley of Maerhku, Minshan range, alt. 2700 m., no. 13407 (fol.), Nov. 1925 (shrub 1.50–2.40 m.; much branched, leaves white beneath), no. 13408 (fol.), Nov. 1925 (shrub 1.20–1.80 m., much branched; leaves green beneath); among rocks and alpine

meadows, Toyüku, Minshan, Pakeshan, alt. 3450 m., no. 13411 (fol.), Nov. 1925 (shrub 90 cm., compact). Upper Tebbu country: Djrakana, southwest of Minshan, outskirts of Abies forest, alt. 3000 m., no. 13417 (fol.), Nov. 1925 (shrub 1.80–2.40 m., branches bronze color; leaves papery, glaucous beneath), no. 13418 (fol.), Nov. 1925 (shrub 1.50–1.80 m.; leaves glaucous beneath).

Southwestern Szechuan (Muli): mountains south of Muli, Mount Gibboh, alt. 3050–3960 m., no. 16823 ♀, May 1928 (shrub 2–3 m.); Mount Mitzuga, west of Muli Gomba, alt. 3050–4875 m., no. 16096 ♀, June 1928 (shrub 1–2 m.); Minya Konka Snow Range, south of Tatsienlu, alt. 4600 m., no. 17526 ♀, July 1929; Mount Siga, northeast of Kulu, alt. 4300–4450 m., no. 17887 ♀, June 1929 (shrub 1.50 m.), no. 17889 ♂ (shrub 0.90–1.20 m.).

The specimens from Szechuan are generally more vigorous and have larger and thicker catkins than those from Kansu and Eastern Tibet, but do not differ otherwise. The sometimes peculiar habit which induced Schneider to propose *S. squarrosa* as a distinct species, is seen also in Tibetan specimens (e. g. no. 13927). It is probably only a monstrosity and may be due to injuries by grazing animals, insects or climate. Some of the numbers cited show perhaps traces of hybridization, particularly with *S. Wilhelmsiana*, but it is hardly possible to give a more exact interpretation of these forms lacking either leaves or flowers.

Salix myrtillacea × Wilhelmsiana (S. taoensis) Goerz, hybr. nov.

Eastern Tibet. Grasslands between Labrang and Yellow River: Gochen valley near mouth at Yellow River, south of Dzangar lamassery, alt. 3060 m., nos. 13909 ♂, and 13911 ♀, May 14, 1926 (shrub 3 m.); rocky gorge of Serchen leading to Yellow River gorge, southeast of Radja, alt. 3120 m., no. 13915 ♂, May 14, 1926 (shrub 2.40–3 m.). Radja and Yellow River gorges: rocky slopes back of Radja Gomba, alt. 3300 m., no. 13921 ♂, May 20, 1926 (shrub 3 m., branching from near base); valley of Nyavruch north of Radja, lateral valley, along rocky streambed, no. 13930 ♀, May 27, 1926 (shrub 1.80–2.40 m.); north of Radja, Yellow river valley, alt. 3150 m., no. 14033 ♀, May 28, 1926 (shrub 3–3.6 m.).

Southwestern Kansu. Tao River basin: forest of Choni, along Tao river, no. 12099 ♂, May 1925 (shrub 2.40–3 m.); Choni, banks of Tao river, alt. 8200 m., May 1925, nos. 12103 ♂ (shrub 1.5 m.), 12104 ♂ (shrub 1.2 m.) and 12105 ♀ (shrub 1.5–1.8 m.); mountains of Choni, Picea forest outskirts, alt. 2700 m., no. 12106 ♀, May 1925 (shrub 1.8–2.4 m.); southern bank, Choni, no. 12265 ♀, June 1925 (shrub 1.5–1.8 m.). Minshan range: in ravines of Kadjaku, alt. 3150 m., no. 12377 ♀, June 1925 (shrub 1.8–3 m.; catkins small grey); Choni, alt. 2550 m.,

Nov. 1925, nos. 13401 (fol.) (shrub 1.5 m., much branching), 13403 (ram.) (shrub 1.5–2.4 m., branches red, branchlets pubescent), 13404 (fol.) (shrub 1.5–2.4 m., branches red, pubescent; leaves pubescent on both sides), 13405 (fol.) (shrub 1.2–1.5 m., branches dark red, leaves white beneath) and 13406 (fol.) (shrub 2.4–3 m., branches green); Kadjaku, along stream, alt. 2240 m., no. 13416 (fol.), Nov. 1925 (shrub 1.5–1.8 m., branches stiff, blackish; leaves green beneath). Lower Tebbu country: along stream near Nyiba, alt. 2550 m., no. 14963 (fol.), Oct. 1926 (shrub 3–4.5 m.; leaves bluish grey beneath).

This hybrid is in localities where the two parent species occur, apparently not only very frequent, but also exceedingly polymorphous. On account of the incompleteness of the material it is not always possible to draw the lines between them and the parents. One may assume that the hybrid is fertile and that by recrossing with the parent the limits become indistinct. Thus e. g. no. 12105 is very near *S. Wilhelmsiana* and also no. 13911 with its slender catkins may represent a recrossing with *S. Wilhelmsiana*, while others might be interpreted as forms of *S. myrtillacea*. Not rare seems to be a combination of the staminate catkins which resembles those of the European *S. purpurea* (e. g. nos. 12099 and 12103) or those of its Caucasian variety *virescens* Anders. (no. 12104). Likewise the shape of the leaves changes from narrow-oblanceolate to narrow obovate. No. 14963 has leaves resembling those of *S. tenuijulis* Ledeb. which ranges from the Tianshan to Armenia; the leaves, however, differ from that species not only slightly in the serration, owing to the influence of *S. Wilhelmsiana*, but also lack completely the stipules which are so characteristic for *S. tenuijulis*. Besides the leaves are in October still furnished on both sides with the long acroscopic hairs of *S. Wilhelmsiana*. No. 12265 represents a somewhat intermediate leaf shape, broad-lanceolate to oblanceolate with short point; the serration extends here in contrast to *S. myrtillacea* almost to the base and the pubescence is lacking entirely on the mature leaves. The hybrids show also in habit an intermediate character. While *S. Wilhelmsiana* generally attains only a height of 1.6 m., *S. myrtillacea* grows into a shrub up to 4 in. tall. Among the hybrids shrubs up to 3 m. are found.

Salix myrtillacea × Rockii Goerz, hybr. nov.

Eastern Tibet. Radja and Yellow River gorges: alt. 3150 m., no. 13953 ♂, May 25, 1926 (shrub 2.4–3 m.); with Spruces on northern slopes of valley south of Yellow River, opposite Radja, alt. 3150 m., no. 14112 ♀, June 10, 1926. Jupar Range:

along streambed in upper Jupar valley, alt. 3600 m., no. 14349 ♀, 1926 (shrub 1.8–2.4 m.).

In the male plant the filaments are mostly connate and besides often villous up to the apex. Nos. 14112 and 14349 have well developed leaves which are about intermediate between the parents; they are densely denticulate almost to the base. In no. 13112 the longer, parted and somewhat spreading stigmas indicate the influence of *S. Rockii*. In no. 14349 perhaps *S. Wilhelmsiana* is involved besides *S. Rockii*, as suggested by the comparatively small fruiting catkins.

Salix Delavayana × **myrtillacea** Goerz, hybr. nov.

Southwestern Szechuan (Muli): Mount Mitzuga, west of Muli Gomba, alt. 3050–4875 m., no. 16038 ♂, June 1928 (shrub 2 m.).

This Willow resembles *S. Delavayana* but differs chiefly in the lack of the dorsal nectary (the ventral one being nearly 1 mm. long) and the mostly ½–⅔ connate filaments. The floral bracts are long and densely bearded. Perhaps *S. spodiophylla* Hand.-Mazz. belongs partly to this hybrid.

Sect. INCERTA

Salix Alfredi Goerz, spec. nov.

Frutex vel arbor ad 4.5 m. alta, ramulis tenuibus, recentissimis laxe pilosis citissime glabris, anniculis vetustioribusque brunneis vel fuscis, opacis vel rarius nitidulis; gemmae semiconicae, obtusae, glabrae, brunneae. Folia in petiolo piloso 3–5 mm. longo, recentissima plana, utrinque laxe sericea (subtus pilis longis laxis acroscopicis, supra pilis brevioribus), postea utrinque glabrescentia (costa ventrali, ut videtur, persistentius puberula), ovato-lanceolata, ca. 1:2½, basi rotundata, apice plus minusve triangulari, supra opace viridia, subtus pallide vel caesio-glauca, integra; stipulae 0. Amenta (♀ tantum nota) coaetanea, subsessilia, bracteis minutis caducis suffulta, anguste cylindrica, gracilia, 3–4 cm. longa, 2–3 mm. crassa, postea ad 5.5 cm. longa, 6 mm. crassa, laxiflora, rhachi albohirsuta; squamae obovatae, ca. 0.7 × 1 mm., subbrunneae, utrinque dense sat breviter albo- vel subrufo-hirsutae; nectarium ventrale minutum (0.3–0.4 mm. longum), oblongum, dorsale; pedicellus brevissimus (brevior quam nectarium) vel nullus; germen minutum (ca. 1 mm. longum), conicum, acutatum, breviter albo-pilosum, stylo subnullo, stigmatibus 0.2 mm. longis plus minusve lobatis divaricatis vel suberectis; capsula ad 2 mm. longa, parcius pilosa.

Southwestern Kansu. Tao River basin: mountains of Choni, west of Taoho, alt. 3000 m., May 1925, nos. 12147 (fol.) (shrub 1.5–2.4 m.), 12149 ♀ (shrub 2.4–3 m., outskirts of Picea forest). Upper Tebbu country: in limestone gorges en route to Tebbu land, southern slopes of Minshan, alt. 3300 m., no. 12522 ♀, June 1925 (shrub or small bushy compact tree 4.5 m.).

Nearest to this graceful Willow in habit is perhaps *S. hylonoma* Schneid., which differs in the denticulate leaves, the dense-flowered catkins, the long narrow nectary, the parted style and, as it seems, also in the larger size of all its parts. The young catkins of *S. Alfredi* are also similar in appearance to those of *S. heterochroma* Seemen, but also these are dense-flowered and have entirely different styles and stigmas and besides longer pedicels. Owing to the lack of staminate flowers, it does not seem possible to refer this new species to any of the sections.

The species is named in honor of Alfred Rehder, Curator of the Herbarium of the Arnold Arboretum.

Page 38

POLYGONACEAE

Polygonum Auberti L. Henry.—Add the following number:

SOUTHWESTERN KANSU. Tao River basin: along stream between Taochow and Kan-ku, alt. 2450 m., no. 13210, Aug. 1925 (huge climber forming dense masses; flowers cream-colored).

Page 39

RANUNCULACEAE

Clematis aethusifolia Turcz.—Add the following no.:

CENTRAL KANSU. Lien hoa shan: alt. 2750 m., no. 12753, July 14–20, 1925 (climber; flowers yellow, sepals with cream-colored margins).

Page 41.

Clematis brevicaudata DC.—Add the following no.:

CENTRAL KANSU. Lien hoa shan: along bank and over shrubs, alt. 2750 m., no. 12750, July 14–20, 1925 (climber, flowers cream-colored).

Page 42.

Clematis glauca var. **akebioides** f. **phaeantha** Rehd.—Add the following no.:

CENTRAL KANSU. Lien hoa shan: beyond Yitao, loessy slopes, alt. 1500 m., no. 13228, Aug. 1925 (climber; flowers purplish-brown).

Clematis tangutica var. **obtusiuscula** Rehder & Wilson.—Add the following no.:

SOUTHWESTERN KANSU. Tao River basin: around Choni, alt. 2600 m., no. 12917, July 1925 (forming large straggling scandent bushes, common; flowers brownish yellow).

SAXIFRAGACEAE

Page 51.

Hydrangea Bretschneideri Dippel.—Add the following no.:

SOUTHWESTERN KANSU. Tao River basin: below Choni, along shady banks of Tao River, alt. 2500 m., no. 12228, June 1925 (flowers white).

ROSACEAE

Page 72.

Rubus idaeus var. **strigosus** Maxim.—Add the following no.:

EASTERN TIBET. Radja and Yellow River gorges: spruce forests, northern slopes of River valley; south of Radja, no. 13986, May 25, 1926 (flowers white).

LEGUMINOSAE

Page 84.

Hedysarum multijugum Maxim.—Add the following nos.:

EASTERN TIBET. Radja and Yellow River gorges: grassy northern banks of river near Radja, alt. 3000 m., no. 14002, May 27, 1926 (flowers purple). Ba valley: on loess bluffs, alt. 3000 m., no. 14244, June 1926; on loess bluffs and banks of lateral ravines of valley, alt. 2850 m., no. 14363, July 1926.

ERICACEAE

Page 106.

Rhododendron rufum Batal.—Add the following no.:

SOUTHWESTERN KANSU. Tao River basin: Maerkhu valley north of Minshan, Abies and Picea forest, alt. 3200–3350 m., no. 13675, Sept.–Oct. 1925 (in fruit; flowers pink).

VERBENACEAE

Page 112.

Caryopteris incana Miquel. . . .
Caryopteris Mastacanthus Schauer. . . .
Change to:

Caryopteris tangutica Maximowicz in Bull. Acad. Sci. St. Pétersb. XXVII. 525 (1881); in Mél. Biol. XI. 301 (1881).—P'ei in Mem. Sci. Soc. China, I. no. 3, p. 172 (Verbenac. China) (1932).

A specimen collected by Purdom (no. 792) in the Taochow District also belongs here. The two numbers of the Rock collection cited by P'ei as nos. 12709 and 12755 are mistakes for no. 12765.

CAPRIFOLIACEAE

Page 120.

Lonicera microphylla Willdenow.—Add no. 14070 to the last specimen cited as "three days north of Radja, alt. 3350 m."

COMPOSITAE

Determined by J. MATTFELD

Aster incisus Fischer in Mém. Soc. Nat. Moscou, III. 76 (1812).—Hemsley in Jour. Linn. Soc. Bot. XXIII. 412 (1888).

SOUTHWESTERN KANSU. Lower Tebbu country: gravelly rocky banks of Peshwekiang, alt. 2000 m., no. 14556, Aug. 30, 1926 (shrub 60–90 cm.; flowers white).

Aster Limprichtii Diels in Fedde, Rep. Spec. Nov. Beih. XII. 503 (Bot. Reis. Hochgeb. Chin. Ost-Tib.) (1922).

SOUTHWESTERN KANSU. Lower Tebbu country: Oak forest near Nyipa village, Mayaku, alt. 2300 m., no. 14803, Sept. 9, 1926 (shrub 60–90 cm.; flowers white); dry shale slopes under Oaks at Nyipa in Mayaku, alt. 2400 m., no. 15055, Sept.–Oct. 1926 (shrub 60–90 cm.; flowers pinkish white).

Aster poliothamnus Diels in Fedde, Rep. Spec. Nov. Beih. XII. 503 (Bot. Reis. Hochgeb. Chin. Ost-Tib.) (1922).

EASTERN TIBET. Radja and Yellow River gorges: among conglomerate boulders in valley near Radja lamassery, alt. 3000 m., no. 14201, June 1926 (flowers lavender).

A distinct and handsome species with numerous lavender-colored flower-heads.

Microglossa salicifolia Diels in Bot. Jahrb. XXIX. 612 (1900).

SOUTHWESTERN KANSU. Lower Tebbu country: gravelly rocky banks of Peshwekiang, alt. 2050 m., no. 14555, Aug. 30, 1926 (shrub about 1 m.; flowers white); banks of stream, Peshwekiang gorge, alt. 2050 m., no. 14800, Sept. 5, 1926 (forming large clumps; flowers white).

Tanacetum Rockii Mattfeld, spec. nov.

Frutex parce ramosus; rami vetustiores lignescentes, cortice griseo tenuiter rimoso obtecti, hornotini herbacei, simplices sursum tantum ramulosi, supra basin foliis delapsis nudi, deinde laxe foliati (internodiis 1–3.5 cm. longis), costati, tenuiter appresse pilosi, deorsum glabrescentes, sursum griseo-tomentelli. Folia sursum magnitudine sensim decrescentia petiolata; petioli tomentelli, 2–5 mm. longi, basi utrinque lobulo herbaceo stipuliformi ornati; laminae ambitu fere rotundatae, 1–2 cm. latae, 1–1.7 cm. longae, basi truncatae et deinde breviter in petiolum angustatae, margine vix ad tertiam partem sinuatae, supra virides, dense granuloso-punctatae, subtus dense appresse incano-tomentosae, palminerviae, nervis subtus leviter prominulis e basi 3 rarius 5, venam unicam saepius tantum emittentibus, exeuntibus in lobos, lobi 3, inaequi-

formes, apicali iterum trilobulato, lobulo medio late ovato usque subquadrato, interdum utrinque 1-dentato, ca. 3–6 mm. longo, 5–7 mm. basi lato, lateralibus oblique ovatis, lobis 2 lateralibus grosse sinuato-tri-crenatis, crenis deorsum magnitudine decrescentibus, lobulis omnibus obtusiusculis breviter mucronulatis. Inflorescentiae paniculato-corymbosae, axes inferiores ex axillis foliorum orientes bene foliati, 20–6 cm. longi, superiores axi primario brevius longiusve adnati, bracteis foliaceis integris oblanceolatis sparse obsiti, 5–2 cm. longi, omnes corymbulo parvo glomeruliformi, 1–2.5 cm. diametiente, bracteolis parvis lineari-lanceolatis usque filiformibus obsito terminati, pedunculis propriis tomentellis 0.5–3 mm. longis. Capitula minuta, heterogama; involucri globosi, apice constricti, ca. 2–2.5 mm. diametientes et alti; squamae 3–4-seriatae, glabrae, exteriores ovatae, 1.2–2.2 mm. longae, 0.8–1.2 mm. latae, subobtusae, interiores late ovato-rotundatae, 2–2.5 mm. longae, 1.8–2 mm., latae, latissime scariosae; receptaculum convexum, vix 1 mm. diam., nudum, glabrum; flores omnes fertiles, marginales feminei uniseriati, tubulosi, lobis 5 ovato-lanceolatis 0.5 mm. longis inclusis 2 mm. longi; corolla sparse glandulis megacephalis sessilibus obsita ceterum glabra; flores disci tubulosi hermaphroditi, sparse glandulosi, 2.2 mm. longi, tubus 1 mm. longus, subito paullumque ampliatus in limbum lobis 5 ovatis 0.5 mm. longis inclusis 1.2 mm. longum; styli rami 0.5 mm. longi, apice truncato barbulati; germen epapposum, oblique obovoideum, glabrum, vix striatulum, (coctum) mucilaginosum.

Southwestern Kansu. Lower Tebbu country: banks of Chulungapu near Wantsang, 1980 m., no. 15097, Sept. 1926 (plant 60–90 cm.; flowers yellow).

Aliam speciem generis hacum foliorum forma camparandam frustra quaesivi, nisi habes folia ceterum longe alieni *Chrysanthemi sinensis* aliquo modo pro similia; notabilia etiam achaenia ecostata, minutiuscule striatula, mucilaginosa ita iis Artemisiarum similia.

Tanacetum salicifolium Mattfeld, spec. nov.

Suffrutex e basi parce ramosus, 30–40 cm. altus; rami vetustiores foliis delapsis nudo, lignescentes, cortice griseo, tenuiter rimoso obtecti, foliorum fasciculo rosulante, anno sequente ramum fertilem terminalem evolvente terminati; innovationes e ramis vetustioribus (iam defoliatis) hornotini steriles, breves, 3–10 cm. longi, deorsum laxe sursum dense fasciculatim foliati; rami floriferi simplices e rosula singuli, 12–20–30 cm. alti, inflorescentia terminati, usque ad apicem laxe foliati (internodiis 0.5–2 cm. longis), fuscescentes, tenuiter arachnoideo-tomentelli. Folia herbacea, simplicia,

anguste lineari-lanceolata, (2–) 5–7 cm. longa, 2–5 (–10) mm. lata, basin versus sensim longeque petiolatim angustata vel fere rite alato-petiolata et deinde basi dilatata ramo affixa, apicem versus tardius angustata, obtusiuscula et mucronata usque breviter acuminata, margine integerrimo saepius minute revoluta, supra viridia, primum laxe arachnoidea demum glabrescentia, subtus incano-tomentella, nervo tenui percursa. Inflorescentia corymbosa, semiglobosa, saepe glomerata, 3–4 (6) cm. diametiens et aequealta; pedunculi communes dense tomentosi, 3–6-capitulati, 1–1.5 (–4) cm. longi, pedunculi proprii 1–3 mm. longi; capitula heterogama pluriflora; involucri demiglobosi, 4–6 mm. diametientes; squamae ca. 4-seriatae, dorso herbaceae, laxe arachnoideae, late fusco- vel atrofusco-membranaceo-marginatae, exteriores late ovatae acutae, interiores late obovatae, apice lacerato late rotundatae obtusissimae; receptaculum nudum, glabrum, ca. 1.5 mm. diam., convexum; flores omnes fertiles, marginales feminei uniseriati; corolla anguste cylindrica, sursum attenuata, vix 3 mm. longa, sub lobis 4–5 ca. 0.6–0.8 mm. longis constricta, glandulis sessilibus obsita; flores disci hermaphroditi cylindrico-tubulosi, sursum paullum ampliati, 3.5 mm. longi, glandulis sessilibus obsiti, lobi 5 ca. 0.5 mm. longi; styli rami breves, apice truncato barbati; germen epapposum, angulato-obovoideum, glabrum, eglandulosum, costatum, florum marginalium dorso applanatum.

CENTRAL KANSU: Lien hoa shan: among limestone rocks on summit, alt. 3450 m., no. 12693 (typus) July 1925 (shrub 60–90 cm., flowers yellow).

NORTHERN SZECHUAN: Dongrergo, Gebüschhänge mit Spiraea, Potentilla, Juniperus, 4000–4200 m., *Harry Smith*, no. 3529, Aug. 8, 1922; same locality sonnige Blockhänge bei Huang-lung-ssu, 4000–4150 m., *Harry Smith*, no. 3620, July 22, 1922.

SOUTHWESTERN SZECHUAN (Muli Kingdom): mountains between Wa-Erh-Dje and Muli Gomba, in open meadows, 4350 m., no. 16918, Aug. 8, 1928 (height 60–180 cm., flowers yellow).

Species nova foliis integris anguste lanceolatis inter alias species generis eximia. Specimen no. 16918 foliis amplis ad 10 cm. longis et 1 cm. latis longius acuminatis, inflorescentia paullum altiore, statura elatiore a typo differt.

Tanacetum falcatolobatum H. Krashenikov in Not. Syst. Herb. Petrop. IV. 7 (1923).

CENTRAL KANSU. Yellow River basin: rocky gorge of Hsining beyond Hsiang tang, alt. 2125 m., no. 13246, Aug. 1925 (woody plant, 0.3–0.6 m.; flowers yellow).

EASTERN TIBET. Radja and Yellow River gorges: among rocks, banks of river, alt. 3050 m., no. 14193, June 1926 (shrub 0.6 m.; flowers yellow).

Pertya sinensis Oliver in Hooker's Icon. XXIII. t. 2214 (1892).

SOUTHWESTERN KANSU. Upper Tebbu country: Spruce forests of Drjakana, overlooking Yiwaku valley, alt. 3200 m., no. 13100, Aug. 3, 1925 (shrub 2.5–3 m., with scandent branches; flowers pink); among Picea and Abies trees, forest of Drjakana, alt. 3050 m., no. 14588, Aug. 1926 (shrub 3 m.; flower-heads slender, purplish). Lower Tebbu country: on banks of streams in Wantsang forest, alt. 2225 m., no. 14668, Aug. 31, 1926 (shrub 1.25–1.50 m.); along streams and rocky banks, Mayaku, alt. 2450 m., Sept.–Oct. 1926 (shrub; flower-heads single).

Pertya discolor Rehder in Jour. Arnold Arb. x. 135 (1929).

CENTRAL KANSU: en route to Lin-hoa-shan from Choni via Taochow, among scrub, no. 12667 (type), July 1925 (shrub 1 m., florets dark purplish red).

(To be continued)

CYTOLOGICAL STUDIES OF CORNUS

HAIG DERMEN

With plate 53

THERE ARE some forty or more species of *Cornus*, of which some thirty forms are in cultivation at the Arnold Arboretum. This genus has quite a wide distribution all through the northern hemisphere, with one species in the tropical mountains of Africa (Wangerin 1910). According to Berry (1923) over fifty fossil forms have been described, the oldest of these coming from the Upper Cretaceous period; the majority of other forms have been found all through the Tertiary formations.

Out of fifty existing forms described by Wangerin (1910) and Rehder (1927) twenty-four are found in central and eastern Asia, two in western Asia, one in western Asia and Europe, ten in Atlantic North America, six in Pacific North America, three in Central America, one in Alaska and middle western United States, one in Africa and two in the boreal and arctic circumpolar region. All but the last two mentioned are woody while the latter forms are perennial herbs.

Twenty-three species of *Cornus* and one species of *Nyssa* were studied and their chromosome numbers determined. *Cornus canadensis* material was procured from the woods near Pepperell, Mass. This species was studied from aceto-carmin smear preparations of pollen mother cells. The other species were from the Arboretum plants. Five of these were studied both from root-tip section preparations and from aceto-carmin smears. The others were determined from root-tip sections. Representative forms are illustrated in Plate 53. The technique of obtaining root-tips for cytological preparations is described in an earlier publication (Dermen 1931).

A table is given below showing the basis of the taxonomic grouping of the genus *Cornus* based on Rehder's classification (1927), but with slight alterations, and the corresponding chromosome grouping of the species investigated.

TABLE I.

A. Flowers in cymes or panicles without an involucre.

B. Leaves alternate.....(10 pairs of chromosomes)
Cornus alternifolia, C. controversa.

BB. Leaves opposite.....(11 pairs of chromosomes)
Cornus alba, C. alba Rosenthalii, C. stolonifera, C. stolonifera flaviramea, C. stolonifera coloradensis, C. rugosa, C. Amomum, C. obliqua, C. arnoldiana, C. asperifolia, C. glabrata, C. racemosa, C. paucinervis, C. coreana, C. sanguinea, C. Bretschneideri.

AA. Flowers in dense umbels with an involucre.
B. Flowers yellow with a yellowish involucre not exceeding the flowers and deciduous during anthesis.....(9 pairs of chromosomes)
Cornus mas, C. officinalis.
BB. Flowers greenish yellow with large white or pink bracts.
C. Woody plants.....(11 pairs of chromosomes)
Cornus florida, C. kousa chinensis.
CC. Herbaceous plant.....(22 pairs of chromosomes)
Cornus canadensis.

From the above table it is seen that chromosome numbers correspond to the system of taxonomic grouping. This investigation showed four groups of species with basic chromosome numbers 9, 10, 11, 22. In Plate 53 are illustrated meiotic and mitotic figures as representative of cytological groups. Meiotic chromosomes of *C. mas* (fig. 1) are considerably larger than the meiotic chromosomes of *C. florida* (fig. 2) and much larger than the chromosomes of *C. canadensis* (fig. 3). These size differences are also noticeable in the somatic chromosomes (*C. mas*, fig. 4; *C. florida*, fig. 5). Both meiotic and somatic chromosomes of *C. officinalis* correspond in size and structure to the *C. mas* chromosomes. *Cornus kousa chinensis* (fig. 6) was similar to *C. florida* in all respects; both had one pair of chromosomes with minute trabants. There were no trabants observed in any other species. The chromosomes of the *C. alba* group were somewhat smaller than the chromosomes of the *C. mas* and *C. florida* groups. In this, as well as in the *C. florida* group a pair of chromosomes were noticeable that were conspicuously longer than the others, with double constrictions (*C. stolonifera*, fig. 7; *C. stolonifera flaviramea*, fig. 8). Most of the other chromosomes had subterminal constrictions (*C. paucinervis*, fig. 9). *Cornus controversa* (fig. 10) and *C. alternifolia* have 20 chromosomes. In these species there were found four chromosomes that were much longer than the others in the cell. It was difficult to find a cell with chromosomes in a flat position making it possible to illustrate this point; however, with careful observation these differences could be noticed. Winge (1917) has reported for *C. racemosa* (*C. candidissima*) the chromosome count n = 8–9 and for *C. glabrata* n = 11–12. Both these species have 11 pairs of chromosomes.

Attempts were made to study other genera that are classified either within the family Cornaceae or in Nyssaceae to see in what respects they may have affinities to the genus *Cornus*. *Nyssa sylvatica* was the only species available for a study of chromosome number, size, and structure. This species has 44 chromosomes (fig. 11) quite small in size, but showing at least two pairs of chromosomes noticeably longer than the others. Several efforts were

made to study *Helwingia japonica* and *Davidia involucrata* (the only species of these genera available in the Arboretum) but the chromosomes were found too crowded together, thus making an accurate count difficult. The chromosome number for *Davidia* was estimated 40 ± and for *Helwingia* 80 ±. Both had small chromosomes like *Nyssa*. The root-tip cells of *Cornus*, *Nyssa* and *Davidia* were of the same nature; half of them were thick walled showing the presence of a gummy substance. *Helwingia* did not possess these gum cells.

Cornus mas (fig. 4) and *C. officinalis* have 9 pairs of chromosomes. The somatic chromosomes of these forms indicate the presence of 2 pairs with median or submedian constrictions. These 3 pairs are longer than the other chromosomes of the group. When other forms are compared with these, one finds that all the chromosomes are quite short with only one long pair and with a double constriction. From these facts it may be concluded that the two median constricted pairs were segmented, giving rise to the four extra chromosomes of the 11 pair group. The chromosomes of the 10 pair group showed two pairs that were considerably longer than the others. In this case, apparently only one of the nine pairs was segmented to give rise to this additional pair. The 22 pairs of chromosomes of *C. canadensis* undoubtedly are from the duplication of the 11 pairs of some species like *C. florida* or some herbaceous diploid form. To shed some light on the origin of this species with a tetraploid number of chromosomes, the author intends to study *C. suecica*, another herbaceous species, and some other varieties of *C. canadensis*.

From the chromosome counts and structure it is suggested that nine pairs may be taken as the basic number of the genus and that other forms with 10, 11, and 22 pairs are merely alterations of this basic number due to segmentation of some chromosomes and duplication in the case of *C. canadensis*. There is evidence in supporting the hypothesis that fragmentation of chromosomes may give rise to new forms. Stern (1928) gives a case described by Seiler that clearly demonstrates this point. There were found two races of butterflies, *Phragmatobia fuliginosa*, one with 28 and the other with 29 pairs of chromosomes. Seiler finds that the long chromosomes of the 28 pair race are four units long, while in the 29 pair race the long chromosomes are three units long. When these races are crossed he finds that long chromosomes pair with the fragmented chromosomes. Anderson (1931) has made a comparative study of the chromosomes of the genera *Allium* and *Nothoscordum*. The genus *Nothoscordum* is considered closely

related to the genus *Allium*. In *A. stellatum* he finds seven pairs of chromosomes, while the characteristic number for the genus is eight pairs. In *N. bivalve* are found nine pairs. In the nine chromosomes of the microspore, seven were with median or sub-median constrictions and two with terminal constrictions. In the words of the author, "These latter are conspicuously marked by large, deep-staining insertion points. The chromosomes, like those of *Allium*, are large and ribbon-like. The attachment constrictions in *Allium* are usually median or sub-median (or at most sub-terminal). It seems quite possible that *Nothoscordum* may have been derived from an eight-chromosomed parental stock by the division of one of the large median-constricted chromosomes. This is further borne out by the fact that the combined length of the two chromosomes with terminal constrictions is only a very little greater than that of the longest chromosome with a median constriction." Thus it may be assumed that when a long chromosome is fragmented from the point of so-called "spindle fiber attachment point," then the derived chromosomes build up anew their own spindle fiber attachment constrictions.

It may be safe to assume that a species with a small number of chromosomes is the most primitive of its genus. Taking the cytological findings based on number, size and structure of chromosomes, it may be said that a type like *C. mas* is the most primitive of the genus and others are derivatives of this, both in respect to cytological characteristics and morphology of inflorescence.

Unfortunately, due chiefly to difficulties of cultivation, the Arboretum does not have some of the species like *C. Volkensii*, *C. cilicia*, *C. Nuttallii*, etc. that could have helped to make this study more complete. These species mentioned are of special interest because of their geographical distribution and because, in some cases, of their close resemblance to other forms, like *C. Nuttallii* to *C. florida*, the former growing in Pacific United States and the latter in Atlantic United States.

The present distribution of these species suggests that *Cornus* was an ancient genus dating back into the Lower Cretaceous period, before, according to geographical formations discussed by Fernald (1931), the Arctic Ocean had connection with the Gulf of Mexico, when there were supposed to be land connections between North America and Europe, Africa was connected with Europe and Transcaucasia was the land bridge between Europe and Asia. The facts that *C. mas* has the least number of chromosomes and other points indicated above, and that there are many varieties of *C. mas* growing all through that region, and that Transcaucasia

is in the middle point of the early geographical formation of the earth, indicate that forms with higher number of chromosomes may have been derived from *C. mas* and these forms spread to the left through Europe and America and to the right through Asia and down to the present African tropical mountains. Two species, *C. alternifolia* and *C. controversa* (alternate leafed), with two additional chromosomes are very similar. The former has moved to the west occupying Atlantic North America and the latter moved to the present tropical regions of the East Indies, China, Korea and Japan. Other forms with four additional chromosomes must have originated from *C. mas*, changing morphologically in some respects but retaining the opposite position of leaves. Other species with 11 pairs of chromosomes are most likely derivative forms of a species like *C. florida* or may very well be direct descendants of *C. mas*.

It was stated above that *Nyssa sylvatica* had 44 chromosomes and that there were observed two pairs of chromosomes considerably longer than others. If this observation is correct, then this genus may be considered a derivative form of a Cornus species with 11 pairs of chromosomes.

In connection with the chromosome study of *Cornus*, pollen grains of 25 species were measured and the percentage of pollen grain abnormality was determined.

TABLE II.

Name of Species	Per Cent of Pollen Grain Abnormality	Measurement in μ
C. alba Rosenthalii	15	215
C. alba Kesselringii	50	260
C. stolonifera	2	215
C. stolonifera flaviramea	2	215
C. stolonifera coloradensis	5	260
C. rugosa	30	205
*C. Slavinii**	15	215
C. Amomum	30	280
*C. dubia**	65	245
C. obliqua	4	250
*C. arnoldiana**	80	190
C. asperifolia	25	200
*C. Dunbarii**	75	215
C. glabrata	2	215
C. racemosa	50	180
C. coreana	10	215
C. Bretschneideri	2	205
C. florida	10	170
C. florida rubra	95	160
C. kousa	70	135
C. kousa chinensis	3	125
C. mas	3	110
C. mas flava	3	110
C. officinalis	2	110
C. canadensis	10	110

In the above table are given the species that were studied and recorded. Species with asterisks are hybrids. These are given in Rehder's Manual of Cultivated Trees and Shrubs, 1927. The measurements in microns are 180–280 for *C. alba* group, 125–170 for *C. florida* group, 110 for *C. mas* group, and 110 for *C. canadensis*. This record shows most strikingly that chromosome number and size do not control the size of pollen grains, while on the other hand, each group has its characteristic measurement. It was also found that *C. mas*, *C. florida*, *C. kousa*, *C. officinalis*, and their varieties develop their pollen grains in the fall, while others develop theirs in the spring. In this respect there was found an affinity between the *C. mas* and *C florida* groups. *Cornus canadensis*, while related to *C. florida*, develops its pollen grains in the spring. This difference may be due to its being an herbaceous form.

From all the above facts it is suggested that *C. mas* or a similar species is the most primitive type; that the *C. alba* group may be considered as a derivative group from the *C. florida* type or directly from the *C. mas* type; and that the *C. florida* and *C. alternifolia* groups are parallel derivatives from the *C. mas* type. *Cornus canadensis* should be considered a derivative from the *C. florida* type. At present nothing can be said concerning *Davidia*, only that the root-tip cells were similar to *Cornus* and *Nyssa*, and that the chromosome number is estimated to be 40 ±.

BIBLIOGRAPHY

Anderson, E. (1931). The Chromosome complements of *Allium stellatum* and *Nothoscordum bivalve*. (Annals of the Missouri Botanical Garden, **18**: 465–468.)

Berry, E. W. (1923). Tree ancestors. Williams and Wilkins Co., Baltimore.

Dermen, H. (1931). A study of chromosome number in two genera of Berberidaceae: *Mahonia* and *Berberis*. (Jour. Arnold Arb. **12**: 281–287.)

Fernald, M. L. (1931). Specific segregations and identities in some floras of eastern North America and the Old World. (Rhodora, **33**: 25–63.)

Rehder, A. (1927). Manual of cultivated trees and shrubs. The MacMillan Co., New York.

Stern, C. (1928). Fortschritte der Chromosomen. Theorie der Vererbung. (Ergebnisse der Biologie, **4**.)

Wangerin, W. (1910). Cornaceae. (Das Pflanzenreich, IV–229.)

Winge, O. (1917). The chromosomes, their numbers and general importance. (Compt. Rend. Trav. Labor. Carlsberg, **13**: 131–275.)

Cytological Laboratory, Arnold Arboretum,
Harvard University.

DESCRIPTION OF PLATE 53

Fig. 1. *C. mas*. Second metaphase plate showing at one pole 9 chromosomes.
Fig. 2. *C. florida*. First metaphase plate with n = 11 chromosomes.
Fig. 3. *C. canadensis*. First metaphase plate with n = 22 chromosomes.
Fig. 4. *C. mas*. Metaphase plate from root-tip section with 2n = 18 chromosomes.
Fig. 5. *C. florida*. Metaphase plate from root-tip section with 2n = 22 chromosomes.
Fig. 6. *C. kousa chinensis*. Metaphase plate from root-tip section with 2n = 22 chromosomes.
Fig. 7. *C. stolonifera*. Metaphase plate from root-tip section with 2n = 22 chromosomes.
Fig. 8. *C. stolonifera flaviramea*. Metaphase plate from root-tip section with 2n = 22 chromosomes.
Fig. 9. *C. paucinervis*. Metaphase plate from root-tip section with 2n = 22 chromosomes.
Fig. 10. *C. controversa*. Metaphase plate from root-tip section with 2n = 20 chromosomes.
Fig. 11. *Nyssa sylvatica*. Metaphase plate from root-tip section with 2n = 44 chromosomes.

Cytological Studies of Cornus

LEAVES FROM A COLLECTOR'S NOTE BOOK

ERNEST J. PALMER

With one text figure

Gainesville, Fla., April 6, 1931.

THE UPLANDS about Ocala, where we began collecting today, are covered for the most part with a deposit of fine sand overlying the soft porous limestone, which latter deposit is quarried extensively here for road building. These sandy uplands support a mixed growth of Pine (*Pinus echinata* and *P. caribaea*) and of deciduous species, amongst which are *Carya alba*, *Quercus laurifolia*, *Q. cinerea*, *Q. rubra*, *Q. Chapmanii*, *Q. stellata* var. *Margaretta*, *Diospyros virginiana*, *Crataegus constans*, *C. amica*, *C. inopina*, *Rubus cuneifolius*, *Prunus umbellata*, *Rhus quercifolia*, *Ceanothus microphyllus*, *Asimina speciosa*, and *Viburnum rufidulum*. In dryer places this gives place to a more stunted growth, largely of shrubby species, locally known as scrub, in which *Quercus Catesbaei*, *Q. myrtifolia*, and *Q. cinerea* are often common, with *Xolisma ferruginea*, *X. lucida*, *Osmanthus americana* and sometimes *Pinus clausa*. Many interesting herbaceous plants grow here also, of which *Lupinus diffusus* is one of the most common and conspicuous.

Most of the *Crataegus* of the open upland woods, including the three species mentioned above, belongs to the very distinct *Flavae* group, and the trees have a strange appearance with their generally stiff, recurved, branches, slender drooping branchlets, and trunks covered with thick black bark, that is deeply fissured and divided vertically and horizontally, having much the appearance of that of the Flowering Dogwood.

We drove out in the forenoon to the Ocala National Forest, and as we reached the lowlands and flood plains along the Oklawaha River, which we crossed near Silver Springs, it was interesting to note the sudden change in the character of the forest. Cabbage Palmettos growing amongst the Pines, just before we reached the river, looked strangely incongruous.

The soil of the river valley is stiff and black and largely calcareous. The Pines disappear and give place to *Taxodium distichum*, *Quercus nigra*, *Ulmus floridana*, *U. alata*, *Celtis laevigata*, *Crataegus viridis* and *Fraxinus profunda* var. *Ashei*,[1] with *Rhus Toxicodendron*

[1] **Fraxinus profunda** var. **Ashei**, var. nov.

A typo differt foliolis glabris vel raro secus nervos parce tomentosis, sepalis minoribus 1–1.5 mm. longis.

A slender tree 10–12 m. tall, with ascending branches and trunk up to 3–4 dm. in diam. Bark rough and deeply furrowed. Leaves ovate-lanceolate in outline, 1.5–3.5

and *Sabal glabra* amongst the undergrowth. Some of the dwarf Palmettos here were nearly two meters tall. A few trees of *Quercus Shumardii* were seen growing just above the swampy flood plains.

In the afternoon we stopped just north of the boundary of Alachua County, near the village of Micanopy, to examine the *Crataegus*, of which several species were in bloom. Besides *Crataegus egens* and *C. Brittonii*, another species was abundant, which from the characters of the flowers and leaves apparently belongs to the *Parvifoliae* or *Uniflorae* group, but differs in habit from most of them, as it becomes a small spiny tree 3–4 m. tall. The flowers are single or two or three together and have 20 stamens, yellow anthers and 5 styles, as in *C. uniflora*, and also have the large conspicuously glandular-serrate calyx lobes of that group.

dm. long; leaflets 5–9, usually 7, ovate-lanceolate or lance-elliptic, cuneate or rarely rounded at base, acuminate at apex, usually entire, petiolules of the lateral leaflets 5–15 mm. long, those of the terminal leaflet 2–5 cm. long, glabrous or rarely with tufts of brown tomentum along midrib and principal veins; fruit in ample panicles, 5–18 cm. long; samaras flattened, spatulate-lanceolate or linear-lanceolate, 3.5–6 cm. long, 0.6–1 cm. wide, obtuse, rounded, or retuse at apex, longitudinally striate on wings and less conspicuously so on body of seed on which the wing is decurrent to the middle or below; fruiting calyx narrowly campanulate 4–5 mm. long including the ovate-lanceolate calyx-lobes, which are 1–1.2 or rarely 2 mm. long.

This small tree, which inhabits the wet river swamps of the coastal plain from Maryland to Florida, seems to be intermediate between *Fraxinus caroliniana* and *F. profunda*, with both of which specimens have been confused. Specimens in the herbarium of Arnold Arboretum, from the Apalachicola River, Florida, have the young branches and leaves densely pubescent as in typical *Fraxinus profunda* to which they are correctly referred, but I have seen specimens from River Junction, Florida, in which the mature leaves are glabrous, and other specimens appear to be intermediate, and for this reason I think it better to regard the glabrous or sparsely pubescent form as a variety of *F. profunda* rather than a distinct species.

My attention was first called to this tree by Mr. W. W. Ashe, for whom the variety is named, and on whose notes and collections I have drawn to supplement my own made this season in the region where it grows.

Maryland: Dorchester Co., *J. A. Cope*, Sept., 1923; eastern shore, *G. Beasley*, June 20, 1922; Potomac River swamps, s. of Washington, *W. W. Ashe*, Sept. 18, 1927. Virginia: Alexander Island, Alexandria Co., *W. W. Ashe*, nos. 1, 6, and 7, Sept. 18, 1924; near Alexandria, *Jos. H. Painter*, no. 912, Aug. 9, 1904. North Carolina: On Brogaw River, near Northeast Cape Fear River, Pender Co., *W. W. Ashe*, Oct. 30, 1928; Pender Co., *E. J. Palmer*, no. 38256, March 28, 1931; Raleigh, *W. W. Ashe*, no. 1008, Oct. 10, 1895; Hillsboro Road, Raleigh, *J. G. Ashe*, April 20, 1924. Georgia: Athens, *J. H. Miller*, no. 103, Sept. 1923. Florida: Santa Fe River, Alachua Co., growing in water, *W. W. Ashe*, June 4, 1892; near Hildreath, *W. W. Ashe* (**type**) May 15, 1929; between Ft. White and Hildreath, *W. W. Ashe*, June 4, 1929; Oklawaha River swamps, Marion County, *W. W. Ashe*, April 26, 1923; between Ocala and Sulphur Springs, Marion County, *W. W. Ashe*, April 14, 1923; River Junction, without date, *W. W. Ashe;* Kissimmee, Osceola County, *E. J. Palmer*, no. 38356, April 2, 1931; low swampy woods along Oklawaha River, near Silver Springs, Marion County; *E. J. Palmer*, no. 38404, April 6, 1931; low wet woods, near St. Marks, Wakulla County, *E. J. Palmer*, no. 38507, April 10, 1931. Indiana: in a pond about 2 miles n. of Brownstown, *C. C. Deam*, no. 11987, Aug. 8, 1912; very sandy soil, low woods, n. shore of Bass Lake, Starke Co., *C. C. Deam*, no. 17916, Aug. 19, 1915; very low place in White River bottoms 3.7 miles e. of Mendora, Jackson Co., *C. C. Deam*, no. 19038, Sept. 13, 1915; on an old beach line, n. side of Bass Lake, Starke Co., *C. C. Deam*, no. 21063, Aug. 22, 1916; low place along roadside, 4 miles s. of Columbus, Bartholemew Co., *C. C. Deam*, no. 30251, Sept. 27, 1919. Missouri: Campbell, *B. F. Bush*, nos. 436, Aug. 15, 1895, 6596, April 19, 1912. Louisiana: Harvey's Canal, New Orleans, *R. S. Cocks*, no. 30, April, 1902.

Tallahassee, Fla., April 7th.

Our first stop this morning was a few miles south of Gainesville, where *Crataegus* was abundant and several species were in bloom, growing in deep fine sands. The species collected in the thickets and along the border of open woods here were *C. integra*, *C. impar*, *C. fortis*, *C. adusta* and *C. gregalis ?*, as well as the *Parvifoliae* species, like the one we saw at Micanopy yesterday. Here also it becomes a small pyramidal tree, 4–5 m. tall, with intricate spiny branches.

Near Bronson *Xolisma lucida* was growing in a small swamp filled with the Pond Cypress, and some of the specimens were 4–5 m. tall.

In sandy upland woods near Chiefland, Levy County, *Crataegus amica* and *C. egens* were in bloom, and in burned over ground there were large patches of *Castanea alnifolia*, both sterile and fruiting, none of them more than 3–5 dm. tall.

About noon we crossed the Suwannee River at Old Town and stopped on the west side for lunch and to work the collections. *Betula nigra* is growing on the river banks here. The leaves appear to be small and unusually thick for the species, but it can scarcely be more than a geographical form. *Viburnum obovatum* was also collected here in young fruit, but with a few clusters of flowers still remaining. It is a small tree here, the largest specimens being 6–7 m. tall. *Quercus lyrata*, *Q. stellata* var. *Margaretta*, *Acer rubrum* var. *Drummondii* and the curious little Cycad, *Zamia floridana*, were also collected, and I photographed a fine clump of *Lupinus villosus* in sandy soil along the river bank.

April 10th.

This morning, accompanied by Dr. Harper and a local ornithologist we set out to visit the old town of St. Marks, near the mouth of the River of the same name, where a good deal of botanical collecting has previously been done. About ten miles south of Tallahassee we stopped in a bit of flat pine woods to examine a colony of broad leaved trees and shrubs occupying a little depression or hammock. A large tree of *Cornus florida* was in bloom here. The trunk below the first fork, which was only about a meter and a half above the ground, was over 3 dm. in diameter, and the height of the tree, though not measured, must have been 9 or 10 meters. A little further on we found *Crataegus viridis* quite abundant in low wet woods and in the sandy soil on higher ground we collected *Bumelia reclinata*, which was here a shrub about a meter high.

Near Newport, on the St. Marks River, the Florida Elm (*Ulmus floridana* Small) is abundant in the low wet woods. This tree, although closely related to *Ulmus americana*, has quite a distinct ap-

pearance on account of the conspicuously buttressed bases of the trunks and its small leaves. Some of the trees had a curious appearance from the markings caused by woodpeckers, which for some reason that I am unable to explain encircled the trunks in bands at rather regular intervals, giving them a sort of jointed appearance. We had lunch here at the picnic grounds and afterwards explored the woods, collecting *Juniperus lucayana* and *Viburnum scabrellum*, and in shallow muddy ponds the little Quillwort, *Isoetes flaccida*. Some of the native trees, as well as the Pecans cultivated about the town, were well loaded with great clusters of Mistletoe (*Phoradendron flavescens*), and I secured a photograph of one of these.

A *Crataegus* of the *Crus-galli* group was abundant in the open parts of the swampy woods, and I examined many of them here as well as others later in the day about Wakulla and St. Marks. The type of Sargent's *Crataegus limnophila*[1] came from St. Marks, and it is described as having flowers on slightly villous corymbs and 15–20 anthers of dark rose-color. Some of the trees observed here quite agree with the description in these and other respects, but others growing with them, quite identical in habit, foliage, bark, fruit and other characters, have the flowering corymbs in some cases quite glabrous, and there appeared to be a complete gradation from these to others in which the branchlets and petioles as well as the corymbs and hypanthiums are copiously villous. The flowers of all the trees examined here have 15–20, mostly 20 stamens and red anthers, but specimens collected a few days later at Chattahoochee have only 10 stamens, and slightly villous corymbs. By comparing these specimens with the glabrous species described from Florida by Beadle as *Crataegus pyracanthoides*[2] said to have 7–10 stamens and red anthers, it seems evident that they are both forms of one species, as there is a very clear identity in the foliage, flowers and fruit and all other characters except pubescence and variation in the number of stamens. It seems clear, therefore that these should be regarded as only varieties of one species, and the glabrous form, usually with 10 stamens, but sometimes as many as 20, should be known as *Crataegus pyracanthoides* Beadle, while the form with corymbs and sometimes foliage and branchlets more or less villous becomes *C. pyracanthoides* var. limnophila (Sarg.), comb. nov.

This also shows how impracticable it is to maintain the group distinction made by Beadle between *Crus-galli* and *Berberifoliae*, based merely on pubescence.

[1] Jour. Arnold Arb. III. 3 (1922).
[2] Biltmore Bot. Studies, I. 136 (1902).

About the old town of St. Marks, lower down the river, both the pubescent and the typical varieties of this *Crus-galli* species are even more abundant, and in addition I collected here *Crataegus integra*, *C. amica*, and *C. assimilis*. The Honey Locust (*Gleditsia triacanthos*) is growing in the swampy woods here and some of the trees examined have unusual bark for this genus, that on the old trunks being dark, thick, and very rough, with fissures and ridges divided into short blocks, much as in *Cornus florida* or *Diospyros virginiana*. I photographed the trunk of one tree with this sort of bark, and I think that no one familiar with the typical appearance of this tree farther north would recognize it. However, I can find no differences in the fruit, flowers or foliage to justify regarding it as distinct.

April 11th.

The Apalachicola River, which crosses the western part of Florida is formed by the junction of the Chattahoochee and Flint Rivers, just north of the state line, in Georgia. In this part of Florida it has cut its channel deeply through beds of soft Tertiary limestone, developing in places distinct bluffs and ecological and soil conditions quite different from those of other parts of the state, which accounts for the very interesting and distinct flora. We drove out today with Dr. R. M. Harper and a party of geologists from the State Geological Survey, our objective being Allen Bluff in Liberty County. This is one of the highest bluffs of the coastal plain and it is perhaps the highest in Florida. The precipitous part of the cliff which extends for perhaps half a mile along the river, is formed of horizontal strata of limestone and marl. In places it is quite perpendicular but on the slopes there is an abundant growth of trees and shrubs. The soil on the highest levels above the bluff is of deep sand, but ravines cutting through this have penetrated the calcareous beds, and these support a rich growth of both woody and herbaceous plants. Several small trees of the Tumion (*Torreya taxifolia*) were seen here, and amongst other woody plants were *Hamamelis macrophylla*, *Styrax grandifolia*, *Asimina parviflora*, *Stuartia malacodendron*, *Hydrangea quercifolia*, *Quercus austrina*, *Illicium floridanum* and *Celtis pumila* var. *georgiana*. The Christmas fern was also abundant here as well as other ferns. Some large trees of *Populus balsamifera* var. *virginiana* were growing along the lower part of the bluff. In the sandy open woods above, we collected *Ptelea trifoliata* var. *mollis*, *Clinopodium carolinianum* and *Trichostema suffruticosum*, besides several sorts of *Crataegus*, amongst which were *C. integra*, *C. condigna* and *C. armentalis*, besides a small tree of the *Parvifoliae* group, resembling that found near Gainesville, and probably identical with it.

On the return trip our car separated from the rest of the party and took a more northerly route, where following a weatherbeaten and misleading sign, we came out into a piece of deeply rutted sandy country road at places almost impassable and where some of the dilapidated wooden bridges across the streams looked quite dangerous. Before venturing across two or three of the worst of these we stopped to reinforce them by laying loose planks lengthwise for running boards. In the deep sands by the roadside after getting over the worst of this we stopped to collect a little shrub that was in full bloom and very showy with its profusion of violet or purplish flowers. This proved to be *Conradina canescens*, of the Mint family, or a related form somewhat intermediate between that species and *C. puberula*.

April 12th.

This morning we drove out several miles north of Tallahassee, on the invitation of Mr. Goode, manager of the Horseshoe Plantation, to look at a Crataegus tree there. The tree standing near the manager's house is a large symmetrical specimen, about 12 meters tall at a rough estimate. The low conical crown is formed of numerous slender wide-spreading branches, and slightly zigzag branchlets, unarmed or with a very few slender spines. Most of the flowers were gone, but I secured a few belated ones in which the anthers were still unopened. There was an abundance of last season's fruit under the tree. From a study of this material and other specimens in the herbarium of the Arnold Arboretum it appears to belong to the *Ignavae* group of Beadle, which is closely related to if not a part of the large *Flavae* group. And it seems to be quite distinct from any described species.

A description of this species is given below under the name *Crataegus leonensis*,[1] sp. nov. As contrasted with *Crataegus ignava*,

[1] **Crataegus leonensis**, sp. nov.

Arbor ad 10–12 m. alta; truncus interdum 3–4 dm. diam., cortice profunde rimoso fusco-cinereo vel fere nigro; ramuli graciles, flexuosi, sparse spinis 3–5 cm. longis subvalidis armati. Folia ovata, rhombica vel obovata, 2–4.5 cm. longa, 2–4 cm. lata, glabra, papyracea sed firma, breviter lobata, grosse dentata, apice acuta, basi acuta vel in petiolum 1–2.5 cm. longum glandulosum attenuata. Folia ramulorum novellorum ovata vel sub-rotunda ad 6 cm. longa lataque, basi obtusa, rotunda vel fere truncata. Inflorescentiae compactae, 3–7-florae; flores 1.6–2 cm. diam.; stamina 20; antherae roseae; styli 3–5, plerumque 4; pedicelli breves, 8–14 mm. longi, sparse villosi; calyx sparse pubescens; sepala lanceolata vel lineari-lanceolata, 4–5 mm. longa, 1–1.5 mm. lata, manifesto glanduloso-serrata, extus glabra, intus glabra vel parce pubescentia. Fructus subglobosus, 9–12 mm. diam., rubro-aurantiacus vel rubro-brunneus, lenticellis maculatus; calyx prominens, cavo profundo, columno stylari 1–2 mm. alto; pyrenae 3–5, crassae, 7–8 mm. longae, 4–5 mm. latae, extremis obtusis, dorso sulcato.

A tree 10–12 meters tall, with depressed round top and wide-spreading intricate branches. Trunk up to 3–3.5 dm. diameter, clothed with thick, ridgy, dark gray or nearly black bark. Branchlets slender, zig-zag, sparingly armed with stoutish spines, 3–5 cm. long. Leaves glabrous except for a few short villous hairs along midrib and

it is a larger tree, much less spiny, with larger, thinner leaves which are more coarsely serrate on the margins and often broader

FIG. 1.—CRATAEGUS LEONENSIS Palmer

at the base. The fruit is also firmer. The leaves are thinner and larger than in most species of the *Flavae* group, and are quite

veins on upper surface when young, soon entirely glabrous, thin but firm, ovate, rhombic or obovate in outline, 2–2.5 cm. long, 2–4 cm. wide, coarsely dentate and with 2–3 pairs of obscure lobes above the middle, with stout midrib and 3–5 pairs of primary veins, slightly impressed on upper surface, acute at apex, cuneate or attenuate at base and more or less decurrent on the slender, glandular petioles, which are 1–3 cm. in length; on vigorous shoots, broadly ovate to suborbicular in outline, up to 6 cm. diam., obtuse, rounded or rarely truncate at base. Flowers 1.6–2 cm. in diam., in compact 3–7-flowered corymbs, on slightly villous pedicels 8–14 mm. long; stamens about 20; anthers rose or pink; styles 3–5; calyx and ovary slightly villous; calyx-lobes lanceolate or linear-lanceolate, conspicuously glandular-serrate, glabrous without, glabrous or sparsely pubescent within; bracts numerous, linear or linear-spatulate, very glandular, soon deciduous. Fruit subglobose 9–12 mm. diam., single or in few-fruited, erect or spreading clusters, orange-red or russet when fully ripe, or often green mottled with irregular lenticels of russet color; flesh thin, firm, becoming mellow; fruiting calyx rather prominent with wide deep cavity and column 1–2 mm. high, with persistent or tardily deciduous sepals. Nutlets 3–4 or rarely 5, thick and rounded at the ends, plane on the ventral surface and with prominent rounded ridges and two or three shallow grooves on dorsal surface.

Middle and western Florida, growing in sandy open upland woods.

FLORIDA: Horseshoe Plantation, near Tallahassee, *C. S. Sargent*, March 28, 30, 1914; *T. G. Harbison*, no. 2, Sept. 16, 1919, nos. 5645, 5646, April 6, 1920, no. 5645a, Oct. 6, 1920, nos. 6071, 6072 (**type**), April 3, 1923, nos. 6181, 6182, Sept. 27, 1923; *E. J. Palmer*, no. 38557, April 12, 1931.

similar to those of some of the *Rotundifoliae* species. The rough dark bark and conspicuously glandular petioles, as well as its geographical range, indicate, however, that it properly belongs with the southern *Flavae* group.

Mr. Goode later drove us about the plantation, and I saw several other specimens of this proposed species growing in the sandy open upland woods. Other species of *Crataegus* also found here were *C. adunca*, *C. assimilis* and *C. consanguinea*.

In the afternoon Mr. McDougall and I drove out to Wakulla Springs, where I was surprised to find the Washington Thorn (*Crataegus Phaenopyrum*) growing in the low woods. This species has not previously been known as far south as Florida, so far as I know. In the sandy woods, on higher ground in this vicinity we also collected *Crataegus abstrusa*, *C. clara* and *C. consanguinea*, and two or three other as yet unidentified species.

De Funiak Springs, Fla., April 13th.

Leaving Tallahassee this morning, after taking leave of our friends at the State Geological Survey, where we have been making our headquarters, and accompanied by Dr. R. M. Harper, who plans to accompany us as far as Birmingham, Alabama, we turned west and made our first stop at Chattahoochee, just south of the Georgia boundary.

The geological formation here is a rather pure Tertiary limestone, which forms bluffs and steep hillsides along the river and deep wooded ravines leading down from the uplands. The rich limestone soil and humus accumulated along the slopes and in the valleys supports a rich and varied flora, in places quite suggestive of northern woods, but with a mingling of southern plants.

The beautiful and rare Tumion (*Torreya taxifolia*) attains its best development here. This remarkable tree, a relic of the wide distribution it had in an earlier geological period, is represented in America by this species, confined to a narrow belt in Florida and Georgia, and another (*Torreya californica*) on the Pacific coast. In the Old World there are four species in eastern Asia. The trees here were growing on steep hillsides and in the deep ravines. The largest specimen seen was perhaps 10 metres tall, with numerous spreading and ascending branches dividing about a meter above the ground. The trunk below the first branches had a diameter of 3 or 4 decimeters.

Along the river bluffs and ravines were also growing such familiar northern species as *Quercus alba*, *Ulmus fulva*, *Celtis laevigata*, and *Nyssa sylvatica*, and the low shrubby *Viburnum affine* var. *hy-*

pomolacum. The Columbine (*Aquilegia canadensis*) grows on cliffs and rocky ledges, and *Phlox pilosa* is abundant in the open woods. The most interesting discovery was the northern Prickly Ash (*Zanthoxylum americanum*), which I do not think has been reported from Florida before. *Acer leucoderme* is also abundant on the bluffs and *Crataegus spathulata* and *C. pyracanthoides* var. *limnophila* were found in the low woods along the river.

Elba, Ala., April 14th.

We left the camp at De Funiak Springs early this morning and drove out to the south and east, making our first stop at a crossing of Eucheeanna Creek. The soil here is a reddish loam and appears to be rather fertile. On a bank overhanging the creek we found the beautiful orange-flowered *Rhododendron austrinum* in bloom, and also an abundance of Mountain Laurel (*Kalmia latifolia*). This is the second locality in Florida in which I have seen both of these plants growing together, the other being along the Ocklocknee River in Gadsden County. *Cornus florida* was in bloom in the low woods, the flowers being the largest that I have ever seen, some of them having a breadth across the bracts of more than 12 cm. (4 inches).

A little farther south we got into a poor looking wooded country with hills and ridges dissected by deep ravines. We stopped to explore one of these where a spring flowed out producing a rank growth of ferns and flowering plants, with a great variety of trees and shrubs on the banks and along the little stream. Amongst the ferns were the Christmas Fern (*Polystichum acrostichoides*), Beech Fern (*Thelypteris hexagonoptera*) and Cinnamon Fern (*Osmunda cinnamomea*). The Beech (*Fagus grandifolia* var. *caroliniana*), *Magnolia pyramidata*, *Tilia floridana*, and *Amelanchier canadensis*, were growing on the ridges and banks, and farther down I collected *Viburnum densiflorum*, *Symplocos tinctoria*, *Stuartia malacodendron*, *Styrax grandifolia* and *Cornus alternifolia*.

After returning to camp and loading up our paraphernalia, we proceeded west to Crestview, where we turned south and were soon in the Florida National Forest. *Crataegus lacrimata* is abundant in the sandy open woods about De Funiak Springs and between there and Crestview. It has a very distinct and striking appearance, from the stiff recurved branches and slender pendulous branchlets with very small, spatulate, glabrous leaves, and abundant flowers in small clusters closely set along the branches. The bark is dark and thick, with the ridges curiously cross-fissured, dividing them into short blocks, as is common in this group. Some

of the trees attain a size of 8–9 meters, with trunk diameter of 2 dm. or more.

We were in search of a rare Oak described from this locality a few years ago by Mr. Ashe, as *Quercus caput-rivuli*, and later referred by him to *Quercus arkansana* var. *caput-rivuli*. We stopped for lunch at an abandoned ranger station in a clearing of the Pine woods. The pretty little *Phlox Hentzii* and *Lithospermum Gmelini* were growing in the sands here.

After finishing lunch and working the collections I set out to explore some ravines just back of the house. The fine sand here is underlaid by harder loam and clay, eroding rapidly into these deep ravines with steep or precipitous sides, that work their way back into the uplands. In one of these I soon came upon several specimens of the Oak I was looking for, some of them having acorns. The trees growing here, as well as some seen later in the day, some miles to the north, have straight ascending branches, forming slender pyramidal crowns, and with smooth pale bark. This gives them a rather different appearance from *Quercus arkansana* as it grows in Arkansas and Alabama, and although there is little in the foliage or fruit to distinguish them, it is perhaps best to regard the Florida trees as a variety.

Along these ravines I also collected *Illicium floridanum*, *Clinopodium coccineum* and *Prunus alabamensis*. The last has not, so far as I know, been found in Florida before, and has only been known from limited areas in Alabama and Georgia.

Between Niceville and Laurel Hill, not far from the Alabama line, I again saw *Quercus arkansana* var. *caput-rivuli*, growing in similar situations to the other station and of quite similar habit. *Crataegus lacrimata* was also abundant here, and the little legume *Lupinus Westianus*, was growing in the sandy woods. Along a little creek north of Laurel Hill and just before we crossed the state line, *Clifftonia monophylla* was abundant and in full bloom. Here also I collected *Ilex decidua* and a curious form of *Liriodendron Tulipifera*, the small leaves of which have short, rounded lobes.

Troy, Ala., April 15th.

Our first stop this morning was along a creek near Elba, where we stayed last night, and on the banks of the stream we found the orange-flowered Azalea (*Rhododendron austrinum*) in bloom. This seems to be a northward extension of the known range for this species, which has only been known previously from a few localities in Florida, I believe. The Mountain Laurel and shrubby Pawpaw (*Asimina parviflora*) were also growing here. Three miles north of

New Brockton we collected *Crataegus senta*, growing in open sandy woods. This was a good-sized tree, perhaps 7 meters tall, with the thick rough bark and recurved branches, characteristic of the *Flavae* group. *Crataegus calva*, growing near, has a somewhat similar habit, but was here a smaller tree, and it has larger, more showy flowers.

After passing through Enterprise, and near the west edge of Dale County, we stopped to collect in sandy open woods, and here were found *Crataegus lacrimata*, *C. lenis*, *C. attrita* and *C. gilva*. *Quercus Catesbaei* and *Q. stellata* var. *Margaretta* were also abundant here, and a low *Opuntia* was growing in the sand and nearby, along a little creek we found *Cornus alternifolia* and *Rhododendron canescens*. Near Ozark we added *Crataegus incilis*, and *C. opima* as well as *Bumelia lanuginosa* to our collection, and near Brundidge *Crataegus segnis* and *C. uniflora*.

About noon we reached the "pocosin," a locality that I had for many years been anxious to visit. After turning off the highway we found ourselves on a poor country road, and began plowing our way through the deeply rutted soft sand, which threatened to stall our heavily loaded car. After some maneuvering and a good deal of pushing we managed to get on and stopped for lunch at a primitive little school house on the edge of the woods.

The pocosin embraces an area of perhaps a hundred acres in the sandy uplands, and is traversed by several ravines and small streams which have their sources here. Although the surface deposit of fine nearly pure sand looks quite similar to that of the surrounding areas, which originally were occupied largely by Pine forest, it is well distinguished and its boundaries clearly defined by its rich and peculiar flora of small deciduous trees and shrubs, many of which are only found here in this part of the state. The cause of this marked difference in flora has not been explained, but the hypothesis suggests itself that it may be due to a difference in subsoil, causing the water content of the porous sand to be retained longer than in the surrounding areas, and giving rise to seepage spring along the ravines. Dr. Harper, who was with us and acting as guide, published a short, interesting account of the locality and a partial list of the plants in 1914.[1]

In the very hasty reconnaissance we had time to make it was not possible to get a complete list even of the trees and shrubs, but the following species were collected:

Carya pallida
Quercus alba var. latiloba
Quercus stellata var. araneosa
Quercus laurifolia

[1] Bull. Torrey Bot. Club, XLI. 209–220 (1914).

Quercus velutina	Crataegus bisulcata
Quercus Catesbaei	Crataegus macilenta
Quercus marilandica	Rhus canadensis
Quercus cinerea	Aesculus discolor
Quercus rubra	Prunus umbellata
Quercus arkansana	Acer floridanum
Rhododendron canescens	Tilia floridana
Crataegus Sargentii	Osmanthus americana
Crataegus contrita	Viburnum rufidulum

Quercus arkansana, which was collected here by Dr. Mohr many years ago, but which was not recognized as a distinct species until found by Bush on Red River, in southwestern Arkansas, and described by Sargent in 1911[1] was one of the particular objects of our quest. It is not at all rare here, although not so abundant as in the Arkansas station. I was impressed with the absolute and unmistakable identity of the species in these two widely separated localities as well as the close similarity of soil and ecological conditions under which they grow. There can be no reasonable doubt as to the distinctness of this species, which is one of rarest and most interesting of the American Oaks.

Selma, Ala., April 16th.

We passed through a section of hilly country in Wilcox County, this forenoon, where *Magnolia macrophylla* is quite abundant in open woods along the streams. In Marengo County we crossed a section where a Cretaceous limestone comes to the surface, and the influence of the calcareous soil was plainly seen in the change of flora. Pines were absent here and *Juniperus virginiana* was the only Conifer on the uplands. *Quercus Muhlenbergii* and *Q. Durandii* are characteristic trees in the glades and on the hills. *Crataegus Ashei* was in bloom in the glades. As it grows here it is a very spiny shrub about 3–4 meters tall, with large, handsome flowers. Along the bluffs of Pine Barren Creek, a little farther on Dr. Harper showed us *Dirca palustris* growing along a north-facing bluff.

Near Berlin, Dallas County, we crossed another limestone area and again found *Crataegus Ashei* as well as *C. concinna* and *Rhamnus lanceolata* in the glades and thickets. *Crataegus insidiosa* and *C. frugiferens* as well as an unknown species of the *Pruinosae* group were growing along small streams.

Birmingham, Ala., April 18th.

Dr. H. A. Wheeler, Curator of the Birmingham Museum, who has been our host here, guided us out today to the interesting

[1] Trees & Shrubs, II. 121 (1911).—See also Palmer, E. J. in Jour. Arnold Arb. VI. 195–200 (1925).

locality on Shades Mountain, several miles from Birmingham. I had visited this place with him previously, but was glad of an opportunity to explore it more fully.

There is a scenic road which we followed up the mountain along a line of sandstone cliffs. *Pinus virginiana*, *Quercus marilandica*, *Castanea dentata*, *Celtis pumila* var. *georgiana*, *Amelanchier canadensis* and *Crataegus regalis* were amongst the trees noted here. There are also many interesting herbaceous plants which we did not have time to collect. *Silene Wherryi* and *Senecio plattensis* were conspicuous in the rocky woods. Several ferns are found along the cliffs, one of the most interesting of which is *Asplenium pinnatifidum*, growing in shaded clefts, although it did not appear to be abundant. Besides the Pennsylvanian sandstone, which is found at the lower levels, igneous rocks occur in many places.

At one point where we stopped and spent some time in exploring and collecting, a little stream, Lost Creek, flows across an outcrop of granite and other igneous rocks, which form glades or barrens several acres in extent, and have a distinct and most interesting flora. Over the more exposed parts the vegetation is sparse and consists of mosses, lichens and herbaceous plants, with shrubs and stunted trees that have established themselves in clefts and broken places as well as more abundantly along the rocky margins of the stream.

The rare and pretty little *Dimorpha cymosa* grows in large patches on thin soil of shallow depressions in the granite. *Cheilanthes lanosa*, *Arenaria brevifolia* and *Coreopsis crassifolia* also grow abundantly in the open places. Amongst the woody plants found in the barrens and along the creek are *Quercus Boyntoni*, *Q. georgiana*, *Celtis pumila* var. *georgiana*, *Xanthorrhiza apiifolia*, *Philadelphus hirsutus*, *Amelanchier canadensis*, *Aronia arbutifolia*, *Prunus alabamensis*, *Malus bracteata*, *Crataegus ignava*, *C. venusta*, *Ptelea trifoliata* var. *pubescens*, *Acer rubrum* var. *tridens*, *Oxydendron arboreum*, *Vaccinium sericeum*,[1] *V. vacillans*, *V. tenellum*, *Rhododendron arborescens*, *R. canescens* and *R. alabamensis*.

Quercus georgiana, which is locally abundant, has not before been known from Alabama, and only from the type locality at Stone Mountain, Georgia, and vicinity. It is usually a stout straggling shrub 2–4 meters tall as it grows here, but in better soil in the edge of open woods it sometimes becomes a small tree up to 6–7 meters tall, and with a trunk covered with dark, ridgy,

[1] **Vaccinium sericeum** (Mohr), comb. nov.
Vaccinium melanocarpum [var.] *sericeum* Mohr in Contrib. U. S. Nat. Herb. VI. 658 (Pl. Life Ala.) (1901).
Polycodium sericeum C. B. Robinson in Torr. Bull. XXIV. 570 (1912).

bark. Boynton's Oak (*Quercus Boyntoni* Beadle, or *Q. stellata* var. *Boyntoni* Sargent) is also fairly abundant in the barrens and it is also a shrub 1–3 meters tall. *Vaccinium sericeum* is conspicuous when in bloom on account of its very large flowers, perhaps the largest of any species of the genus. *Prunus alabamensis* is a shrub up to 2–3 meters tall, and it seems to be confined to the rocky glades and creek banks here. *Kalmia* is abundant along the rocky ledges and margins of the creek, and *Rhododendron arborescens*, not yet in bloom, and *Xanthorrhiza apiifolia* were found lower down the creek, where *Cheilanthes tomentosa*, *Thelypteris asplenifolia* and *Tradescantia hirsuticaulis* were also collected. *Rhododendron canescens* and *R. alabamense* were growing abundantly on banks a little above the creek and glades. The latter is rather a rare species and is distinguished by its glabrous winter buds. Over most of the mountain and surrounding region the forest is of larger growth and of mixed stands of Pine (*Pinus echinata*, *P. taeda*, *P. palustris* and *P. virginiana*) and deciduous species, in which Oaks, Hickories, Maple and Ash predominate.

Tupelo, Miss., April 21st.

We came into the little county seat town of Hamilton in a steady rain yesterday evening, and chanced to stop for lodging at a house nearly opposite the district Agricultural High School. After having had supper at the restaurant I talked to our host, a Mr. Love, and explained to him the object of our trip. He proved to be an interesting man, a native of Cape Cod, who had wandered over a good part of the world, and was fond of nature and out-of-doors life. He was much interested in our work and offered to guide us the following morning to some places that he knew, where he thought we would find good collecting.

Accordingly we set out early and after a short drive turned off the highway, near the site of the old town of Pikeville, which flourished in the days before the coming of the railroads. After travelling as far as we could over a rough mountain road we left the car and walked over to Dugan Creek, a small stream that has cut its channel through sandstone beds, which form cliffs and overhanging ledges along its course. On the rocky banks and along the cliffs I noted *Fagus grandifolia*, *Magnolia acuminata*, *M. macrophylla*, *Rhododendron alabamense*, *Corylus americana* and *Tsuga canadenis*, a curious mixing of northern and southern species. The Hemlock is locally abundant here and some of the trees are of a large size. It has been recorded from several other stations in Alabama by Dr. Harper and others. Ferns were abundant, the

following species were noted and collected here: *Osmunda Claytoniana*, *Thelypteris noveboracensis*, *Adiantum pedatum*, *Asplenium pinnatifidum* and *Trichomanes Boscianum*. Several colonies of the *Trichomanes* were found under the overhanging ledges of sandstone where the surface was kept permanently wet by seeping water and where direct sunshine penetrated only for a brief time each day. The fern-like moss, *Fissidens polypodioides*, was growing very luxuriantly with the fern, as well as several other mosses and liverworts.

Holly Springs, Miss., April 22nd.

We drove back several miles this morning to investigate some thickets of *Crataegus* that we noticed yesterday evening, but which we did not then stop to examine on account of the rain. The hills here are calcareous, underlaid with a soft Cretaceous limestone, and *Crataegus* is rather abundant. We stopped at two localities between this place and the little town of Mooresville and found what I take to be *C. tersa*, *C. macra*, *C. frugiferens*, *C. amnicola*, *C. biltmoreana* and *C. apiifolia*, the last growing in low ground along a creek. A species of the *Crus-galli* group was also abundant. It is a small, moderately spiny tree, with slightly villous branchlets and corymbs. It was in full bloom and I secured good specimens, but do not recognize it and suspect that it may be an undescribed species. *Malus angustifolia* was also common and in full bloom in the thickets, and I also found here the little Adder's tongue *Ophioglossum Engelmannii*. Along the banks of the creek near Mooreville the *Malus* was also abundant, and I found *Castanea pumila*, *C. dentata*, *Amelanchier canadensis* and *Rhododendron canescens* var. *subglabratum* along the same stream.

Going back through Tupelo we turned aside to visit a Negro Industrial School, near Okolona, in which the father of my travelling companion had long been interested. We found the wife of the president in charge, apparently a very capable and energetic woman. After visiting several of the buildings, including class rooms, shops and the president's house and seeing the students at lunch in the dining hall, we took a hasty departure, favorably impressed by the rather pathetic, though heroic effort being made to carry on the difficult work of Negro education here with inadequate equipment and in the face of local indifference and hostility.

Between Tupelo and Okolona there is some botanically interesting country. The soft marly limestone comes to the surface in many places, and large fossil oyster shells are abundant. *Crataegus Ashei* is frequent in the thickets as well as the unknown *Crus-galli* species seen near Mooreville. A patch of *Cercis canadensis*, in

which the plants were all shrubby and not more than 2–3 m. tall, had the leaves more than half grown but still retained clusters of flowers on many of the branches.

Sikeston, Mo., April 23rd.

After crossing the Mississippi at Memphis this morning we followed the highway which is built through the wide alluvial valley, making our first stop north of the town of Marion, Arkansas. *Crataegus* trees in full bloom in the low partly cleared woods attracted out attention. On investigation they all proved to be *C. viridis*, which is one of the commonest species of the valley, ranging from the Gulf to northeastern Missouri. I also collected here *Quercus prinus*, *Ulmus crassifolia* and *Ilex decidua*, which last was in bloom and with leaves nearly fully grown but retaining a full crop of bright red berries from the previous year. I remember having found it similarly retaining the fruit a few years ago, near Salisaw, Oklahoma, and from specimens in the herbarium of the Arboretum it would seem that this is not unusual in the southern part of its range.

In the afternoon we made a stop in the lowlands of Pemiscot County, Missouri, near Hayti. Such typical species of the swamps and lowlands as *Taxodium distichum*, *Arundinaria macrosperma*, *Populus heterophylla*, *Planera aquatica*, *Catalpa speciosa*, *Fraxinus profunda*, *Forestiera acuminata* and *Bumelia lycioides* were growing here. *Catalpa* is fairly abundant and is native here. The southern *Bumelia* is rare so far north and I have only seen it at one other station in Missouri, near Neelyville, Butler County.

Cape Girardeau, Mo., April 24th.

This morning we crossed Crowley's Ridge, just west of the town of Campbell, Mo., and stopped for a few minutes to examine the flora. This remarkable bit of relief, surrounded on all sides by the lowlands of the valley, extends along the great river, which at one time is supposed to have flowed to the west of it, from Stoddard County, Mo., to Helena, Ark., some fifty miles below Memphis. In places it rises to a height of more than 100 meters above the surrounding lowlands. The formation consists largely of unconsolidated beds of sand, gravel and clay, with loess becoming more common towards the southern end. It was originally and still is in many places covered with a forest of deciduous trees, including several eastern species which reach their western limit here, and with a flora, rich both in woody and herbaceous species, and very different floristically from that of the surrounding country. Conifers and *Ericaceae* are almost entirely absent, although I remember

seeing a few trees of *Pinus echinata* that had invaded the gravelly hills near Jonesboro, Ark., and the Tree Huckleberry, *Vaccinium arboreum*, is found rarely in the same vicinity. Several species of Oaks, Hickories, Black and Sweet Gum, Beech, Tulip-tree, Elms, Maple, Linden and Ash are the commonest forest trees, with several species of *Prunus*, *Crataegus*, *Malus*, *Viburnum*, *Hydrangea* and other shrubs as undergrowth or in more open places.

The only thing of especial interest found at this place today was a *Crataegus* that may be a hybrid between *C. viridis* and a species of the *Crus-galli* group.

Later in the day we stopped in the outskirts of Poplar Bluff to have a look at *Quercus coccinea* var. *tuberculata*, which with the typical form is found locally on the gravelly hills.

Fredericktown, Mo., April 28th.

Leaving our camp at Cape Girardeau this morning we stopped to examine a bit of low swampy woods, about two miles east of Delta and just before crossing into Bollinger County. This is a remnant of the fast disappearing dense and luxuriant forest of typical coastal plain composition, that formerly covered the lowlands and swamps of this part of the Mississippi valley, extending as far north as the mouth of the Ohio and the Wabash rivers. Lumbering, clearing and drainage have made rapid inroads, and almost the last vestiges of it seem doomed to disappear as the region is being rapidly transformed into a fertile farming section. I have been particularly interested in trying to trace the northern boundaries of this lowland forest and the limits of some of the typical species, where they touch upon the foot-hills of the Ozarks and suddenly disappear.

The forest here had been lumbered some years ago and the land partly drained, but water stands upon much of it in rainy seasons and a second growth is springing up rapidly. The Pumpkin Ash (*Fraxinus profunda*) was common here but nearly every tree had been cut for lumber. Sprouts about the stumps are already beginning to bear fruit. Other common species are *Populus heterophylla*, *Quercus prinus*, *Q. lyrata*, *Q. palustris*, *Q. rubra*, *Carya laciniosa*, *Liquidambar Styraciflua*, *Gleditsia aquatica*, *Fraxinus pennsylvanica* var. *lanceolata*, *Acer rubrum*, *Itea virginica*, *Cornus femina* and *Cephalanthus occidentalis*.

We began this morning by having a puncture while going over a piece of road newly surfaced with coarse gravel, and on account of the rough going we did not discover it until the tube was ruined. This afternoon we got the car mired in trying to straddle a mud hole and spent a couple of hours extricating it, which we did only after

carrying quantities of flat rocks from a hillside to build up as we pried the wheels out, since it was impossible to use the jack. This took so long that by the time we had the car out and loaded again it was too late to go over to the interesting hills, which here form the extreme northern end of Crowley's Ridge, and which I had hoped to photograph. However, we climbed one of the nearest and examined the flora. This is close to the little town of Perkins, Scott County. The hills, rising abruptly from the surrounding lowlands here have a remarkable appearance, made more striking by the fact that while the bottoms have been mostly cleared for cultivation, these ridges are still heavily wooded. Many of the Beech, Oak, Hickory and other trees attain a large size. I photographed one large specimen of Beech and a King-nut tree, the trunks of which had grown together, apparently forming two halves of a composite trunk, for several feet above the base. This is the only part of Crowley's Ridge where I have seen outcrops of stratified rock, the usual gravel and clay deposits here having covered some remnants of the hard Ordovician dolomite, which is being excavated by erosion and is beginning to appear as cliffs and ledges in a few places.

Hugo, Okla., May 26th.

Our camp last night was in a beautiful and rugged part of the Ozarks, a few miles from the little town of Talihina, Oklahoma. After breakfast this morning I started out for a walk of several miles over the steep dividing ridges and deep hollows that, viewed from a high point, extend as far as can be seen in all directions. The prevailing geological formation is Pennsylvanian sandstone, varying greatly in stratification and density at different places. Most of the country is still heavily wooded with a mixed forest of Pine (*Pinus echinata*) and deciduous species of Oaks and Hickories prevailing on the ridges, and many other trees and shrubs along escarpments and ravines and in the deep narrow valleys. Some of the species found in such places are *Juniperus virginiana*, *Castanea ozarkensis*, *Quercus borealis* var. *maxima*, *Q. Shumardii* var. *Schneckii*, *Ulmus alata*, *Nyssa sylvatica*, *Amelanchier canadensis*, *Acer rubrum*, *A. saccharum*, *Cornus obliqua*, *Vitis aestivalis* and *V. rupestris*. Along the rocky margins of a mountain creek I also collected *Carpinus caroliniana*, *Rubus flagellaris*, *Ceanothus ovatus*, *Hypericum oklahomense*, *Mitchella repens*, *Amorpha fruticosa* and another species of *Amorpha*, somewhat resembling *A. glabra*, but with slightly pubescent foliage and branches, which I do not recognize.

In places along moderate slopes hard beds of the sandstone come to the surface, forming glades or barrens, conspicuous in the

forest for the absence of trees. I stopped to examine and to take some photographs in one of these, which was several acres in extent. Conspicuous amongst the large number of herbaceous species here were *Cheilanthes lanosa*, *Camassia esculenta*, *Delphinium azureum*, *Talinum teretifolium*, *Tephrosia virginiana*, *Tragia nepetifolia*, *Ptilimnium Nuttallii*, *Spermolepis echinata*, *Opuntia humifusa*, *Hedeoma hispida*, *Kneiffia linifolia*, *Pentstemon arkansanus*, *Ruellia ciliosa*, *Specularia leptostachya*, *Coreopsis grandiflora* (not yet in bloom), *Thelesperma trifidum*, *Echinacea angustifolia* and *Krigia occidentalis*.

In the afternoon I stopped along a little creek near the village of Finley to photograph some fine blooming specimens of *Yucca arkansana*. A little further on, along the bluffs and banks of Mill Creek, I collected *Tilia floridana*, *Chionanthus virginica*, *Castanea ozarkensis*, and *Amorpha nitens*. A few miles farther south, near Kaimichi, along the bed of a little mountain creek, I found *Salix petiolaris*, *Andrachne phyllanthoides*, and a curious and unknown form of Witch Hazel. This seems to be quite an extension southward of the known range of *Salix petiolaris*, which was previously known from Canada to northeastern Missouri.

The *Hamamelis* is evidently closely related to the spring-blooming species, *H. vernalis*, which is so abundant along the rocky streams of the Ozark region. Although the plants here are smaller than the average for *Hamamelis vernalis*, they have the characteristic stoloniferous habit of that species as well as the rather thick upright leaves of similar type. A form of this species, with slightly tomentulose branches and leaves more or less pubescent along the veins beneath, has been described by Mr. Alfred Rehder as *Hamamelis vernalis* forma *tomentella* †. The type specimen of this form came from Potean, Oklahoma, which is in the same general regions as Kaimichi, and it is also in cultivation at the Arnold Arboretum. However, the Kaimichi plants are so different not only from the typical form of *Hamamelis vernalis* but also from the forma *tomentella* that they can scarcely be regarded as a mere form and be referred to the latter. The leaves are thickly coated beneath with a persistent close felty pubescence, often tawny or reddish along the petioles and veins, and with scattered grayish stellate hairs on the upper surface. The branchlets are also copiously villous-tomentose.

In the original description of *Hamamelis vernalis*[1] Professor Sargent states that the leaves are either glabrous or stellate pubescent on both surfaces, and specimens that he has noted as included in his type material scarcely differ from the type specimen of the

[1] Sargent, Trees and Shrubs, II. 137 (1911).

forma *tomentella*. The foliage of the plants found near Talihina is so different that they appear more distinct than any American species that has been distinguished since the publication of *Hamamelis virginiana*. But since a name has already been given to a tomentulose form of *H. vernalis*, to which this plant is clearly related and since it is likely that other intermediates will be found it is perhaps best to regard all of the tomentose forms as one variety, and I am therefore calling the pubescent plants *Hamamelis vernalis* var. *tomentella*.[1]

About Antlers, Oklahoma, the soil of the uplands is extremely sandy. *Quercus cinerea* grows in such soil, and I found it near here several years ago, but did not see it today. *Crataegus pilifera* is growing here as a small tree 4–5 m. tall, and *C. uniflora* as a slender shrub scarcely a meter tall, but in abundant fruit. *Jatropha texana*, *Lithospermum Gmelini* and *Pentstemon pauciflorus* were also collected in the sandy open woods.

As we approached Hugo there was a marked change in the character of the country and in the flora. Cretaceous limestone comes to the surface in many places and the soil resulting from it is a stiff black gumbo, which is quite fertile, as shown by the better quality of farm improvements and other evidences of prosperity. Woods are confined largely to the vicinity of the streams, with broad stretches of upland prairie, and glades are frequent on limestone outcrops. *Maclura pomifera* is native here, and the little wild Rose *Rosa foliolosa* is abundant. There is also a great profusion of wild flowers in rainy seasons. *Pentstemon Cobaea*, and *Petalostemon albidus* are conspicuous and I also collected the little suffrutescent *Phyllanthus polygonoides*.

Stillwater, Okla., May 28th.

We pitched our tent last night along a pretty little stream, Pennington Creek, near Tishomingo, the county seat of Johnston County and formerly the capitol of the Chickisaw Indian tribe. There is an outcrop of granite in this section, and the creek has cut its channel through the hard igneous rocks, great masses of which lie scattered about, piled up and eroded into the most

[1] **Hamamelis vernalis** var. **tomentella** (Rehder), comb. nov.
Hamamelis vernalis f. *tomentella* Rehder in Jour. Arnold Arb. 1. 256 (1920).
A typo differt foliis supra stellato-pubescentibus, infra glaucescentibus dense stellato-pubescentibus; petiolis nervisque fulvo-pubescentibus. Ramuli juveniles dense fulvo-stellato-pubescentes.
Near Kaimichi, Pushmataha County, Oklahoma, *E. J. Palmer*, no. 39394, May 26, 1931.
The plant here described differs from the form distinguished as f. *tomentella* in being densely felty-tomentose on the under surface of the leaves instead of sparsely stellate-pubescent, and also in the more densely pubescent young branchlets.

fantastic shapes. The locality bears the rather sinister name of the "Devil's Den," and it is much frequented as a summer resort and by campers and fishermen. There is considerable small timber along the creek and in the more rugged or more protected places amongst the granite, but over considerable areas where unbroken beds of the rock come to the surface, trees and shrubs are absent and only small colonies of peculiar herbaceous plants grow in the slight depressions where thin deposits of soil have accumulated and where water stands for some time after rains. In some of the larger depressions there are permanent pools and small ponds. *Juniperus virginiana*, *Juglans nigra*, *Carya Buckleyi* var. *arkansana*, *Quercus stellata*, *Q. Muhlenbergii*, *Q. macrocarpa*, *Q. velutina*, *Q. Schneckii*, *Q. marilandica*, *Ulmus americana*, *U. alata*, *Celtis laevigata* var. *texana*, *C. reticulata*, *Maclura pomifera*, *Prunus lanata*, *Cercis canadensis*, *Sapindus Drummondii* and *Bumelia lanuginosa* are some of the commonest trees, with *Yucca arkansana*, *Rubus ostryifolius*, *Rhus glabra*, *R. copallina*, *R. Toxicodendron*, *R. trilobata*, *Ilex decidua*, *Lonicera albiflora* var. *dumosa* and a few other shrubby species occupying most of the area. Vines are abundant in the woods and amongst the protecting rocks. The following climbing or trailing species were seen: *Smilax hispida*, *S. Bona-nox*, *Cebatha carolina*, *Aristolochia tomentosa*, *Vitis cordiformis*, *V. vulpina*, *Cissus incisa* and *Melothria pendula*.

Confined to the margins of the stream are *Salix nigra*, *S. longipes* var. *Wardii*, *Populus deltoides*, *Alnus maritima*, *Platanus occidentalis*, *Amorpha fruticosa* and *Acer Negundo*. The *Alnus* is very abundant and grows in large clumps, some of the plants being 5–6 m. tall. This species was first found along the Atlantic coast in southern Delaware and Maryland, and is only known in that section and in a small area here in south-central Oklahoma. It seems hard to explain this curious distribution as the two regions are so remote and so dissimilar in many respects.

The Woolly Lipfern (*Cheilanthes tomentosa*) is abundant in the clefts of the granite and *C. lanosa*, *Woodsia obtusa*, *W. oregana*, *Asplenium resiliens* and *A. Trichomanes* were also collected here. *Sedum Nuttallianum* is dominant and almost the only plant over small patches of thin soil in shallow depressions of the granite. *Clinopodium glabrum*, *Froelichia gracilis*, *Crotonopsis ovata* and *Plantago Purshii* are other plants common in the glades, and in somewhat heavier soil *Gaillardia pulchella* is very abundant.

Herbarium, Arnold Arboretum
Harvard University.

PARASITISM OF MYXOMYCETE PLASMODIA ON FUNGOUS MYCELIA

FRANK L. HOWARD[1] AND MARY E. CURRIE

With plate 54

TO FURTHER the general thesis that the Myxomycetes play a rôle in the consumption of fungi which cause wood decay, the digestion and assimilation of the mycelia of chiefly lignicolous fungi by plasmodia was studied after the parasitism of the plasmodial stage of several Myxomycetes upon mushrooms and polypores had been demonstrated (5). Enlightenment upon the problem was sought by observation of the habits of plasmodia in the forest and also by laboratory tests of the feeding habits of plasmodia on pure cultures of numerous fungi. This study has brought to light the mycophagous habit in several species of Myxomycetes, in addition to those already reported (5), and has disclosed a wide range of fungous mycelia capable of being digested by plasmodia.

RELEVANT LITERATURE

The digestion of the mycelia of fungi by slime molds has, with but one or two exceptions, been reported only incidentally by investigators in connection with their study of some other phase of the biology of the group. The work of A. Lister (6) gives us some excellent notes on the behavior of the plasmodium of *Badhamia utricularis*, but only the reaction of the plasmodium to the mycelium of a chance, unidentified fungus was observed. Hilton (3) cultivated *B. utricularis* upon moist bread and he observed that the hyphae of various species of *Aspergillus* and *Penicillium*, which developed on the bread, were dissolved and absorbed by the plasmodium.

Physarum nutans has been credited by Elliott and Elliott (2) with the absorption and destruction of the mycelia of *Bulgaria polymorpha* and *Coryne sarcoides* within the wood of an oak branch. Sanderson (7) frequently encountered *Physarum auriscalpium* Cooke upon the mycelium of *Sphaeronema fimbriatum* which rots tapped surfaces of *Hevea; Physarum reniforme* Lister on the dead cortex of *Hevea* attacked by *Ustulina zonata;* and *Arcyria denudata* Wettst. associated with *Sphaerostilbe repens* in Malaya on fuel heaps of split timber and on small diseased roots of *Hevea.* One cannot read Sanderson's paper without feeling that the plasmodia of Myxomycetes may parasitise fungi responsible for the decay of wood.

[1] Fellow of the National Research Council, 1930–1932.

Skupienski (9) describes the plasmodium of *Didymium difforme* feeding on *Aspergillus glaucus*, *Sterigmatocystis* sp., *Penicillium* sp., *Stysanus* sp., and various other molds, yeasts, and bacteria. He also found that the plasmodium of *Didymium nigripes* would digest the hyphae of *Penicillium* (8). On the other hand, Celakovsky (1) working with *Chondrioderma* (*Didymium*) *difforme* Rost. reported plasmodia as non-mycophagous, since he observed plasmodia envelop spores and hyphae of *Penicillium glaucum*, *Mucor stolonifer* and *Phycomyces nitens*, and later relinquish them unharmed.

MATERIALS AND METHODS

The plasmodia used in these studies were collected in the forest and brought into the laboratory for cultivation on media, or were cultivated directly from spores (4). The cultures of fungi employed were either isolated by the authors or obtained through the generosity of other workers, especially Dr. Irene Mounce and Dr. C. L. Shear.

In the earlier trials (Tables 1 and 2), in order to test the parasitism of plasmodia, petri plates of nutrient agar were inoculated in the center with the fungus being tested, which was allowed to grow until the colony covered about one-half the diameter of the dish before a bit of plasmodium, previously freed from contaminating fungi, was transferred to the culture. The various standard nutrient agar media used for the culture of the fungi included rolled oat, ground corn, ground corn and dextrose, malt extract, and potato dextrose.

In later trials (Table 3), the senior author devised the following technique: using a sterilized instrument, a disk about one centimeter in diameter is cut from the center of a layer of two per cent plain agar in a petri plate (Plate 54, fig. 1) and in the vacancy is inserted a similar disk of nutrient agar upon which the test fungus is growing. When the fungous hyphae grow from the nutrient agar disk into the plain agar, a piece of plasmodium is introduced and its action toward the hyphae observed. This change in technique was made because in previous experiments where a nutrient substratum was employed and where the plasmodium very slowly digested the mycelium, it was difficult to ascertain whether the growth of the myxomycete was due to digestion of the fungus or to absorption of nutrients directly from the agar. In spite of repeated attempts, it was impossible to free certain of the plasmodia from bacterial contaminants, so here again, the non-nutrient, slightly acid agar substratum was an advantage, as it helped to inhibit the growth of bacteria. In the later trials the H-ion concentration of the agars was taken into account and was adjusted to pH. 6.0 ± 0.3.

THE PARASITIC HABIT AND THE INFLUENCING FACTORS

In order first, to determine if the digestion of fungous hyphae by Myxomycetes is affected by the nutrients in different culture media, as has been reported for the consumption of some bacteria by plasmodia, and second, to find a favorable medium, the junior author made a few preliminary experiments in which fungi were grown on five different agar media, namely, potato dextrose, linseed, *Vicia*

TABLE 1.—PARASITISM OF PLASMODIA UPON FUNGI GROWING ON DIFFERENT MEDIA.

Fungus \ Myxomycete	Badhamia magna	Badhamia rubiginosa	Badhamia utricularis	Brefeldia maxima	Hemitrichia clavata	Leocarpus fragilis	Lindbladia effusa	Lycogala epidendrum	Physarum cinereum	Physarum flavicomum	Physarum polycephalum	Physarum virescens	Trichia decipiens
Corn Dextrose Agar													
1. Collybia velutipes	VP	—	—	P	P	—	VP	P	P	—	VP	P	P
2. Pleurotus ostreatus	VP	P	—	P	P	—	—	—	P	—	—	—	—
3. " serotinus	VP	P	—	P	P	—	—	—	P	—	—	—	—
4. Polyporus resinosus	P	N	—	N	P	—	—	—	P	—	—	—	—
Rolled Oat Agar													
1. Pleurotus serotinus	VP	P	—	—	—	—	—	—	VP	—	—	—	—
2. Polyporus resinosus	—	P	—	—	—	—	—	—	—	—	—	—	—
Potato Dextrose Agar													
1. Fomes applanatus	—	P	—	—	P	—	—	—	—	—	—	—	—
2. Pleurotus ostreatus	—	N	VP	N	N	—	—	—	—	VP	VP	—	—
3. " serotinus	—	N	VP	—	—	—	—	—	—	VP	VP	—	—
4. Polyporus resinosus	P	N	—	—	—	—	—	—	—	P	P	—	—
Linseed Agar													
1. Collybia velutipes	—	N	—	—	N	—	—	—	—	—	—	—	—
2. Fomes applanatus	—	N	—	N	—	—	—	—	—	—	—	—	—
3. Pleurotus ostreatus	—	P	—	N	—	VP	—	—	—	—	—	—	—
Vicia Faba Agar													
1. Fomes applanatus	—	—	—	—	—	—	—	—	VP	—	—	—	—
2. " fomentarius	N	—	—	—	—	—	—	—	—	—	—	—	—
3. " pinicola	—	—	—	—	—	—	—	—	N	—	—	—	—
4. Polyporus resinosus	N	—	—	—	—	—	—	—	—	—	—	—	—
5. Polystictus versicolor	VP	—	—	—	—	—	—	—	—	—	—	—	—

N—not parasitic, P—parasitic, VP—very parasitic.

Faba, rolled oat, and corn dextrose. Plasmodia were transferred to the plates in which the fungi were growing and the results of their parasitism on the mycelia are presented in Table 1. The relative terms used in Table 1 and in subsequent tables to describe the degree of parasitism of the myxomycete, based upon the criterion of the

rate of digestion of the fungous mycelium, are: "very parasitic," "parasitic" and "not parasitic." "Very parasitic" denotes a case in which the mycelium of the fungus was rapidly and usually completely consumed, as for example, the case of *Badhamia magna* on *Collybia velutipes*. Where "parasitic" is recorded, the mycelium was more slowly and usually not entirely consumed. "Not parasitic" is recorded when the mycelium was not digested, even though the plasmodium may have passed over it.

The incomplete data recorded in Table 1 indicate that a plasmodium cannot always attack the same mycelium when grown on a different medium, for example, *Badhamia rubiginosa* attacked and consumed the mycelium of *Pleurotus ostreatus* growing on corn dextrose agar but avoided the same fungus growing on potato dextrose agar. This would seem to indicate that the nature of the medium plays an important part in rendering the mycelium susceptible to attack by a plasmodium. It should be noted, however, that some species of fungi even on the same favorable medium and exposed to plasmodia capable of vigorous parasitism on other fungi, invariably remain unattacked. For example, *Physarum cinereum* avoided the mycelium of *Fomes pinicola* growing on *Vicia Faba* agar but did attack *Fomes applanatus* hyphae growing on the same agar. Examples further substantiating this principle are brought out in later experiments (Tables 2 and 3).

Table 2 shows species of plasmodia which consumed mycelia grown on corn dextrose agar. Petri plates containing this agar were inoculated with different fungi and when a considerable mycelium had developed, four or five cultures of each fungus were inoculated with a small piece of plasmodium. The plates were then incubated at 22° C. This work brings out many idiosyncrasies in the ability of the plasmodia to digest different species of fungi. Some slime molds appear to be generally parasitic upon fungous hyphae while others are only selectively so. The length of life of a plasmodium varied under the conditions of the test, but it was rarely longer than that of a healthy plasmodium growing on corn agar without the fungus.

Although the essential process of assimilation of fungous hyphae is the same for all myxomycetes on all kinds of mycelia, there is great variation in the extent to which and the manner in which hyphae are consumed as a plasmodium advances over a fungus colony (Plate 54, figs. 1–10). Sometimes a plasmodium, advancing across a mycelial culture, digests the mycelium with which it comes in contact and leaves a path freed from fungous hyphae, as does *Physarum polycephalum* on *Collybia velutipes*. Sometimes the plasmodium spreads out in all directions, exposing an ever-widening

circle of bare agar as it consumes the mycelium; such is true of *Trichia decipiens* Macbr. and *Lindbladia effusa* Rost. on *Daedalea confragosa*. And sometimes, if the mycelium is in a tough appressed layer, the plasmodium removes only the superficial hyphae, as for example, *Lycogala epidendrum* Fr. on *Lenzites betulina*.

TABLE 2.—PARASITISM OF PLASMODIA UPON FUNGI GROWING ON CORN DEXTROSE AGAR.

Fungus / Myxomycete	Badhamia magna	Badhamia rubiginosa	Brefeldia maxima	Fuligo septica	Hemitrichia clavata	Leocarpus fragilis	Lindbladia effusa	Lycogala epidendrum	Physarum cinereum	Physarum flavicomum	Physarum polycephalum	Physarum virescens	Stemonitis fusca	Trichia decipiens
1. Collybia velutipes	VP	—	P	—	P	N	P	P	P	—	VP	P	N	P
2. Daedalea confragosa	VP	P	P	—	N	P	P	P	—	—	VP	N	—	P
3. Fomes applanatus	P	P	—	—	P	—	P	P	P	—	—	P	—	P
4. Fomes fomentarius	P	P	P	P	P	—	P	P	P	—	—	—	—	—
5. Fomes igniarius	VP	—	—	P	—	P	P	P	—	—	—	—	—	P
6. Fomes pinicola	N	—	—	—	—	—	—	—	N	—	—	—	—	—
7. Lentinus lepideus	P	N	N	—	P	P	P	P	—	—	P	N	P	N
8. Lenzites betulina	P	P	P	—	P	P	P	P	—	—	P	P	—	P
9. Pleurotus ostreatus	VP	P	P	P	P	P	P	P	P	P	VP	N	N	P
10. Pleurotus serotinus	VP	N	P	P	P	P	P	P	P	VP	VP	N	—	P
11. Polyporus resinosus	P	N	N	N	N	N	P	N	P	P	P	—	—	P
12. Polystictus nigro-marginatus	—	—	P	P	P	—	P	P	—	—	P	P	—	P
13. Polystictus versicolor	VP	—	—	—	—	—	—	—	—	—	VP	—	—	—
14. Polystictus sp.	P	N	—	—	—	—	P	P	—	—	P	—	—	P
15. Poria sp.	N	N	P	P	—	N	N	P	—	—	P	P	—	P
16. Trametes pini	P	N	P	P	P	N	P	P	—	—	P	P	—	P

N—not parasitic, P—parasitic, VP—very parasitic.

The parasitism of plasmodia on fungi growing on rolled oat agar was tried by the senior author with the following results: *Leocarpus fragilis* slowly consumed hyphae of *Monilia* (*Neurospora*) *crassa* and of a *Penicillium* sp. *Physarum polycephalum* rapidly digested the mycelium of *Alternaria* sp., *Aspergillus* sp., *Cyathus stercoreus*,

TABLE 3.—PARASITISM OF PLASMODIA UPON FUNGI GROWING ON DISKS OF OAT AGAR INSERTED IN PETRI PLATES OF PLAIN AGAR.

Fungus	Myxomycete	Arcyria occidentalis	Badhamia rubiginosa	Fuligo septica	Hemitrichia Vesparium	Physarum polycephalum	Physarum tenerum	Trichia persimilis	Trichia scabra	T	BFU	BH	BI	BJ	BX	HH	C14	C16	C30
1. Armillaria mellea		N	—	P	P	VP	VP	P	P	P	VP	P	—	P	P	VP	P	P	VP
2. Bulliardella sp.		N	—	—	—	VP	VP	—	—	—	—	—	—	N	—	—	—	—	—
3. Collybia velutipes		N	N	N	VP	VP	VP	—	N	N	VP	P	N	N	P	N	N	N	N
4. Coprinus micaceus		VP	N	P	P	VP	VP	N	VP	N	N	VP	N	N	P	P	N	N	N
5. Crucibulum vulgare		N	N	N	N	VP	VP	—	N	N	VP	—	N	N	N	N	N	N	N
6. Daldinia concentrica		N	—	N	P	VP	—	—	—	—	—	—	—	VP	—	—	P	VP	—
7. " occidentalis		VP	—	VP	P	VP	—	—	—	—	—	—	—	VP	P	VP	VP	N	—
8. " simulans		N	—	P	P	VP	—	—	—	P	—	—	—	—	VP	P	P	VP	—
9. " vernicosa		—	—	VP	—	P	—	—	VP	P	—	—	—	—	P	VP	—	VP	—
10. Fomes applanatus		N	—	N	N	VP	P	—	N	P	VP	—	—	N	N	N	N	N	—
11. " fomentarius		N	—	P	N	VP	P	—	N	N	VP	N	—	N	N	N	N	N	—
12. " igniarius		P	N	P	P	VP	VP	—	N	N	VP	N	N	—	P	P	P	N	—
13. Ganoderma oregonense		N	N	N	N	P	N	—	N	N	N	N	N	N	N	N	N	N	N
14. Hypoxylon coccineum		N	—	VP	VP	P	—	—	—	N	—	—	—	N	N	P	P	P	—
15. Lentinus lepideus		N	—	N	N	VP	VP	—	—	N	N	—	—	N	N	N	N	N	N
16. Lenzites saepiaria		N	—	P	N	VP	VP	P	N	N	VP	VP	N	VP	N	N	VP	N	—
17. Mycorrhizal fungus		—	—	—	—	VP	P	—	—	P	—	—	—	—	—	—	—	—	—
18. Mytilidion sp.		P	—	—	N	VP	VP	—	—	—	P	—	—	—	N	N	—	—	—
19. Panus stipticus		VP	N	P	P	VP	VP	—	N	N	—	—	N	N	P	P	P	N	—
20. Pholiota adiposa		N	P	P	N	VP	VP	—	N	N	VP	—	N	N	N	N	N	P	—
21. Pleurotus ostreatus		N	—	N	N	VP	VP	—	N	N	VP	N	—	N	N	N	—	N	—
22. Polyporus betulinus		P	—	VP	P	VP	VP	N	N	N	VP	—	N	N	N	P	P	N	—
23. Polystictus pargamenus		N	N	N	N	VP	VP	N	N	N	VP	N	N	N	N	N	N	N	—
24. " versicolor		N	N	P	N	VP	VP	—	N	P	VP	N	—	N	N	P	N	N	N
25. Schizophyllum commune		N	N	N	N	VP	VP	N	N	—	VP	P	N	N	N	N	N	N	N
26. Trametes pini		N	—	N	N	VP	VP	—	N	P	VP	N	N	N	N	N	—	N	N

N—not parasitic, P—parasitic, VP—very parasitic.

Exidia glandulosa, *Merulius americanus*, *Monilia* (*Neurospora*) *crassa*, *Nidularia pulvinata*, *Penicillium* sp., *Tremella mesenterica*, and *Tremella* sp.; but did not digest the hyphae of *Beauveria globulifera*, *Guepinia spathularia*, and *Mucor* sp. *Physarum viride* plasmodia rapidly digested the mycelium of *Chaetomidium fimeti;* and more slowly digested hyphae of *Aspergillus* sp., *Beauveria bassiana*, *Monilia* (*Neurospora*) *crassa*, and a species of *Penicillium*.

A wide range of species of fungous mycelia capable of being digested by various plasmodia was tested by the disk insertion method (Plate 54, fig. 1), and the results are tabulated in Table 3. Occasionally cultures exhibited a puzzling variation in the digestion of the mycelium on oat agar disks and to obviate this, duplicate cultures were prepared. Indeed, in some instances to give added certainty, if the duplicate cultures showed any discrepancy, three to four additional cultures were made. In such doubtful cases, it is the average behavior of three to five plasmodia that is recorded in Table 3. The variation, however, was generally a question of the rate of digestion of the mycelium by the plasmodium. For instance, *Arcyria occidentalis* slowly consumed the mycelium of *Fomes igniarius* in two trials while in a third trial the plasmodium completely digested the mycelium, but in Table 3 this plasmodium is listed merely as "parasitic" instead of "very parasitic." Likewise, out of five trials of *Physarum tenerum* on *Fomes fomentarius*, three gave evidence of parasitism while the other two did not, yet the plasmodium is listed as "parasitic." As previously stated, the variation was commonly one of the degree of parasitism with but one or two exceptions. One exception occurred in the case of *Fuligo septica* digesting *Lentinus lepideus*, in which the plasmodium died on the mycelium in two cultures, avoided the mycelium in a third, but completely consumed it in a fourth.

The fungus listed as "mycorrhizal fungus" (see Table 3), is a subculture of *Mycelium radicis atrovirens* isolated in Sweden by E. Melin and obtained through the courtesy of Mr. A. B. Hatch. This non-sporulating fungus produces a dark submerged mycelium and a lighter aerial mycelium which was consumed by *Physarum polycephalum*, *Physarum tenerum*, and slightly by plasmodium T.

The behavior of the plasmodia in digesting fungous mycelia seems unquestionably to vary with the medium upon which the fungi are growing. The plasmodia of *Physarum tenerum* and *Physarum polycephalum* more rapidly consumed the mycelium of *Schizophyllum commune* from disks of malt extract agar than from disks of rolled oat agar. Another, more striking example, of the effect of the medium upon the ability of a plasmodium to digest a given

mycelium was demonstrated by *Hypoxylon coccineum*. This fungus is very slowly digested on oat agar by the plasmodium of *Physarum polycephalum*, while in repeated trials the same fungus growing on bean pod decoction agar is rapidly consumed by the same myxomycete. It is of interest to note that on the first medium a dark green pigment is produced by the fungus while on the second it is absent, but whether the presence or absence of this pigment is in any way connected with susceptibility to parasitism remains a question. Similarly, a yellow undetermined species (Plasmodium T) digested the white aerial hyphae of *Hypoxylon coccineum* from a disk of bean pod agar but not from a disk of oat agar.

In summarizing the parasitism of plasmodia and the factors influencing it, Tables 1, 2, and 3 demonstrate that the same plasmodium may flourish on the mycelium of one fungus and not attempt to attack that of another species. Plasmodia of the same genus but of different species of slime mold may show as great a variation in parasitism as those of two different genera. In general, it may be said that some Myxomycetes are restricted in choice of host while others seem to be generally mycophagous.

SUMMARY

Laboratory and field observations have disclosed the mycophagous habit of several plasmodia of Myxomycetes other than the fifteen species that the authors (5) recently reported digesting Hymenomycetes, which furthers the hypothesis that plasmodia digest the mycelia of a wide variety of fungi responsible for the decay of wood and debris. The Myxomycetes found to consume fungous hyphae under the conditions of the tests were: 1, *Arcyria occidentalis*, 2, *Badhamia magna*, 3, *B. rubiginosa*, 4, *B. utricularis*, 5, *Brefeldia maxima*, 6, *Fuligo septica*, 7, *Hemitrichia clavata*, 8, *H. Vesparium*, 9, *Leocarpus fragilis*, 10, *Lindbladia effusa*, 11, *Lycogala epidendrum*, 12, *Physarum cinereum*, 13, *P. flavicomum*, 14, *P. polycephalum*, 15, *P. tenerum*, 16, *P. virescens*, 17, *P. viride*, 18, *Stemonitis fusca*, 19, *Trichia decipiens*, 20, *T. persimilis*, and 21, *T. scabra*.

Two methods for testing the parasitic habit were used: one, in which the plasmodia were allowed to attack the fungi on the same nutrient medium upon which the latter were growing, and a second, in which the plasmodia were transferred to petri plates of plain agar, each having an inserted disk of nutrient agar upon which the fungus was growing (Plate 54, figs. 1–2). The mycelia of forty-nine, chiefly wood-inhabiting fungi were tested and were found to be consumed in varying degrees by plasmodia.

Before closing, the junior author wishes to express her thanks to

Professor J. H. Faull for the direction and the advice given during the progress of her work which was carried on at the University of Toronto during 1919–1921. The senior author takes this opportunity to thank Professor J. H. Faull for making possible the joint publication of the observations made independently by the authors, Professor W. H. Weston, Jr., for his interest and counsel given, and the Board of Fellowships in the Biological Sciences for a grant which made this work possible.

LABORATORIES OF CRYPTOGAMIC BOTANY
HARVARD UNIVERSITY

LITERATURE CITED

1. CELAKOVSKY, L., JR. Ueber die Aufnahme lebender und todter verdaulicher Körper in die Plasmodien der Myxomyceten. (Flora **76**: 182–244. 1892.)
2. ELLIOTT, W. T. & J. S. ELLIOTT. The sequence of fungi and mycetozoa. (Jour. Bot. **58**: 273–274. 1920.)
3. HILTON, A. E. Notes on the cultivation of plasmodia of Badhamia utricularis. (Jour. Quekett Microsc. Club ser. 2, **12**: 381–384. 1914.)
4. HOWARD, F. L. Laboratory cultivation of Myxomycete plasmodia. (Amer. Jour. Bot. **18**: 624–628. 1931.)
5. ———— & M. E. CURRIE. Parasitism of myxomycete plasmodia on the sporophores of Hymenomycetes. (Jour. Arnold Arb. **13**: 270–284, pls. 48–49. 1932.)
6. LISTER, A. Notes on the plasmodium of Badhamia utricularis and Brefeldia maxima. (Ann. Bot. **2**: 1–24, pls. 1–2. 1888.)
7. SANDERSON, A. R. Notes on Malayan Mycetozoa. (Trans. British Mycol. Soc. **7**: 239–256. 1922.)
8. SKUPIENSKI, F. X. Recherches sur le cycle evolutif de certains Myxomycetes. Thesis. Paris. 1920.
9. ————. Badania Bio-cytologiczne nad Didymium difforme Duby, czesc pierwsza. (Acta Soc. Bot. Poloniae, **5**: 255–336, pls. 12–18. 1928.)

EXPLANATION OF PLATE 54

Fig. 1. Plasmodium of *Physarum polycephalum* leaving the transferred piece of agar and moving toward the mycelium of *Trametes pini* growing on an oat agar disk which has been inserted in a petri plate of plain agar. Six hours later the fungous hyphae had been completely consumed. × ½.

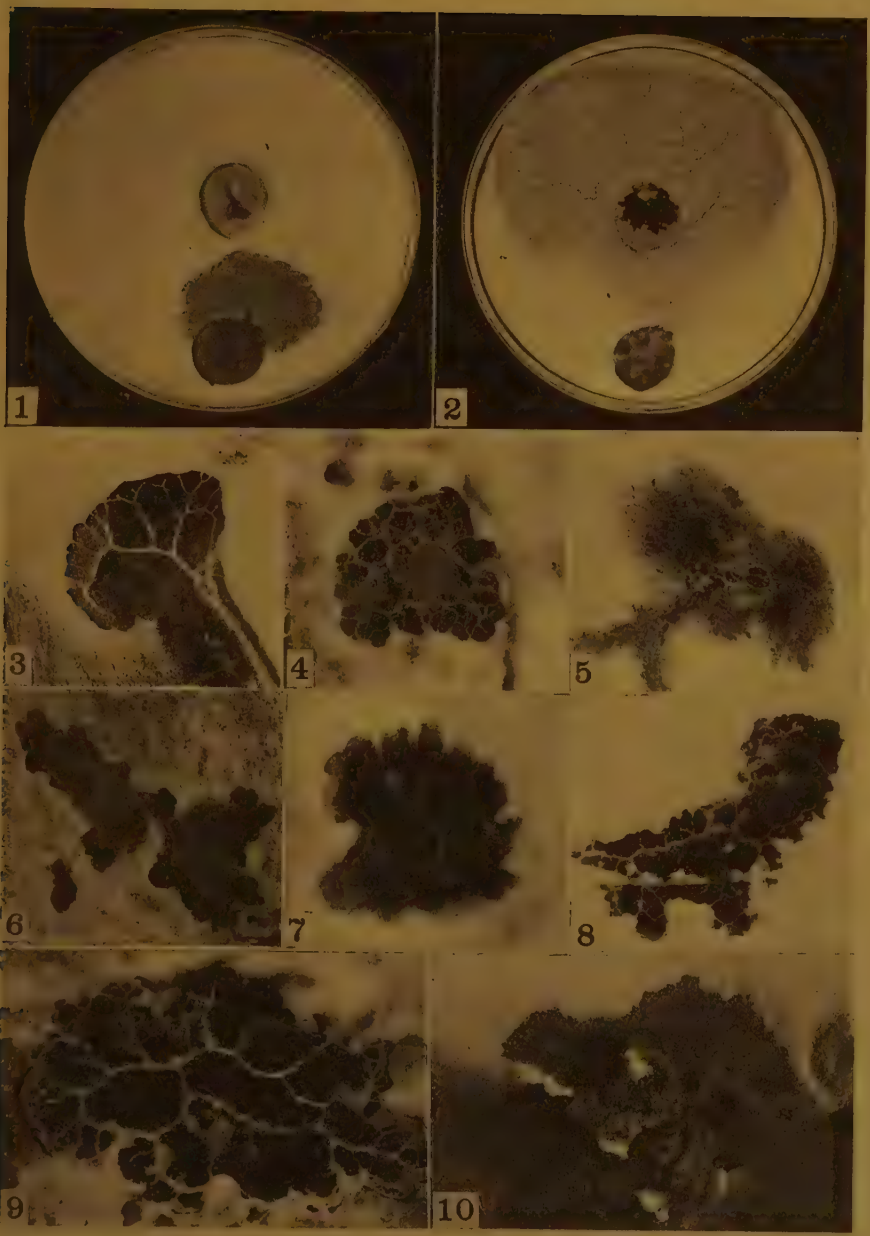
Fig. 2. Plasmodium of *P. polycephalum* consuming the white hyphae of *Fomes igniarius* from an oat agar disk and leaving some of the older dark-colored hyphae.

Fig. 3. Plasmodium of *Physarum virescens* digesting the hyphae of *Fomes applanatus* on corn dextrose agar.

Fig. 4. Plasmodium of *Badhamia rubiginosa* removing the mycelium of *Daedalea confragosa* from corn dextrose agar.

Fig. 5. Plasmodium of *Fuligo septica* dissolving *Fomes fomentarius* hyphae on corn dextrose agar.

Fig. 6. Plasmodium of *Brefeldia maxima* attacking hyphae of *Collybia velutipes*.



Parasitism of Myxomycete Plasmodia on Fungus Mycelia

Fig. 7. Plasmodium of *Brefeldia maxima* parasitizing the mycelium of *Daedalea confragosa* on corn dextrose agar.
Fig. 8. Plasmodium of *Lycogala epidendrum* attacking the hyphae of *Daedalea confragosa*.
Fig. 9. Plasmodium of *Trichia decipiens* removing the mycelium of *Daedalea confragosa* from corn dextrose agar.
Fig. 10. Plasmodium of *Badhamia magna* consuming the hyphae of *Fomes applanatus*.

NOTES

The Arnold Arboretum during the Fiscal year ended June 30, 1932.

Climatically the year 1931–32 proved generally favorable to the growth and well-being of the collections. On February 4th, however, there was a heavy fall of snow that adhered to the trunks and limbs of trees and burdened shrubs and coniferous foliage with a thick mantle of white. Although the landscape effect was exceptionally beautiful in the Arboretum, much damage was done and several weeks had to be devoted to the pruning necessary to remove injured branches. In the spring the rainfall was plentiful and adequately supplied the needs of the plants for moisture. The Cherries and Rhododendrons produced an abundance of flowers and were exceptionally fine.

Now and again, usually through the unintentional carelessness of visitors, fires break out in the arboretum and threaten injury or destruction to valuable specimens. In the spring of 1932, several serious fires, a few doubtless of vandalistic origin, caused distressing damage. One of these menaced Hemlock Hill on April 30th, and before it was finally checked, had destroyed a plantation of Japanese Yews. It is evident that fire is an evil that must be controlled by the most efficient means if the work of years is not to be undone in a few minutes and losses incurred that can never be made good.

We continued our exchanges of plants, cuttings, grafts and seeds and during the year there were sent out 833 cuttings and grafts; 1997 plants and 941 packets of seeds. There were received from other institutions, 1666 plants, cuttings and grafts and 294 packets of seeds.

The publications of the Arboretum, the Journal and the Bulletin of Popular Information, were issued with customary regularity. Of the more than four hundred periodicals, bulletins and reports that come to the Library from all parts of the world, we receive 225 in exchange for our publications. In June the first issue of the new series to be known as Contributions from the Arnold Arboretum appeared, being The Hypodermataceae of Conifers

by Grant Dooks Darker. The second number of the Contributions is in the Press and the third number is under preparation and should be issued in 1933.

One thousand, one hundred and sixty-eight visitors registered at the Administration Building. They came from thirty-one of the United States, from Canada, China, Hawaii, Ireland, England, Egypt, and West Africa.

The "Harvard Experiment Station" situated near the city of Cienfuegos in Cuba, was originally associated with the Botanic Garden of the University under the supervision of the Director. It was founded by Mr. E. F. Atkins of Boston for the purpose of carrying on investigations looking toward the improvement of the varieties of sugar-cane and with the intention of assembling there a representative collection of tropical plants. As the enterprise became more and more closely associated with applied biology, it was transferred to the Bussey Institution of Applied Biology. Early in 1932, the Corporation voted to transfer the Station to the Arnold Arboretum with the title, "Atkins Institution of the Arnold Arboretum." In this regard it is worthy of note and record, that in 1926, Professor Sargent had looked favorably on a proposal to place the Cuban Station under the general control and management of the Arnold Arboretum and had assigned to Professor Jack the task of making a representative collection of the woody plants that grow in the vicinity of Cienfuegos. In recent years, Professor Jack has visited the Institution frequently and has given close attention to the introduction of Cuban woody plants to the living collections, while diligently working on the formation of an herbarium comprising the flora of the surrounding country.

At the end of this report there is appended a bibliography covering the publications of the staff and their students for the year ending June 30th, 1932. This bibliography indicates very clearly the wide extent and varied nature of the investigations that are receiving the attention of the Arboretum.—O. A.

Pathological Laboratory.—The Laboratory in Plant Pathology submits its report for 1931–2, making reference to improved facilities for investigation, extension service and research activities.

Pathological collections constitute an important equipment of our laboratory because they afford both subject matter for study and specimens for reference. Therefore, a consistent effort has been made to add to the materials required for a more comprehensive solution of our immediate research problems, and such as may be useful by way of illustration of as wide a range as possible of plant diseases comprised within the scope of our special field.

Liberal contributions have been received from correspondents, others have been obtained by exchange and many have been collected by members of the staff. Of the last named particular mention should be made of extensive accessions from Europe and America through G. D. Darker and from the western States and New England through J. H. Faull; the former are rich in "needle cast" fungi, the latter in coniferous rusts. Pertinent to this subject I am pleased to report a closer contact with the Farlow Library and Herbarium, recently initiated by the appointment of Arboretum representation on the Administration Board of that institution.

A second step forward in reference to improved facilities is the provision of laboratory accommodation made by the Corporation of Harvard University for research students working on the pathology of woody plants. While the Arboretum does not enroll research students nor regard itself as responsible for the financial support of their work, it does freely and gladly place its rich stores of plants and literature at their disposal, and offers direction in their investigations. Heretofore the students in pathology at the Arboretum have found laboratory space wherever made available through the courtesy of other departments. We now happily record appreciation of the splendid provision made for them in the new Biological Laboratories. They now have their own apparatus and laboratories, and at the same time they enjoy the distinct advantages of being in the centre of the scientific life of the University. During the year six of these research students have been cared for in the new quarters.

Each year brings its quota of requests from far and near for information on the diseases of forests and ornamental trees and shrubs, and the past year has been no exception in this respect. Many of these requests concern known troubles for which means of control are recognized, but occasionally they present subjects that cannot be disposed of offhand. Notably two problems of the latter type, suggested by correspondents, have been added to our program this year. One has to do with the "Gymnosporangium" diseases of Red Cedars, ornamental Apples, Hawthorns, etc., and the other with elm diseases. Grateful acknowledgment is made of material assistance afforded by Dr. and Mrs. Henry Lyman and Mrs. Harold Irving Pratt, respectively, towards the investigation of these problems.

Our investigative undertakings have in part found expression in publication (11 titles); others have not yet reached that stage. Important among the former is a study of the "needle cast" fungi of Conifers by Dr. G. D. Darker; the results, presented in the form

of a handsomely illustrated monograph, have been issued as No. 1 of "Contributions from the Arnold Arboretum of Harvard University." Twenty-four species are described as new, 10 on Firs, 3 on Spruces, and 11 on Pines; also the pathogenicity of 5 species, of a limited number tested, has been established by direct experimentation. Distinct progress has been made on the beech disease problem in which the sequent agencies of an insect and a fungus are involved (John Ehrlich: The Occurrence in the United States of *Cryptococcus Fagi* Dougl., the Insect Factor in a Menacing Disease of Beech. Journ. Arnold Arb. 13: 75–80. 1931). Successful control measures have been tested through the coöperation of the Boston Parks Department. Also field work in the Maritime Provinces, where the trouble has been devastating, is now in course of completion, an undertaking made possible through a liberal grant made by the National Research Council of Canada. Quoting Mr. Richard J. Hayden, Superintendent of Parks, Boston, Mass. from a recent article in Horticulture—"This insect (factor) is new and has not had time to become widespread here. Hence its early eradication may prevent the establishment of a very serious pest." Mention also should be made of the completion of Dr. K. S. Chester's studies on Phytophthora Blight of Lilacs, and of his rectification of an error in the technique, fundamentally important, used by certain investigators in the uncharted domain of plant immunology as a means of recognizing acquired immunity in plants. Dr. Chester will continue his studies during 1932–3 in Europe.

A list of other topics under investigation includes: rusts of Conifers; trunk diseases of Conifers; wilt diseases of Elms; spermogonia of rusts (L. M. Hunter); "cedar apple" diseases of Red Cedar, Apples, Hawthorns, etc. (I. H. Crowell and J. D. MacLachlan); mycorrhiza of trees (A. B. Hatch; Mr. Hatch's present field work in the Black Rock Forest, New York State, is fully supported by a contribution from an unnamed donor through the Director of the Harvard Forest).—J. H. F.

Cytology Laboratory.—During the past year additional cytological studies have been continued to determine the relation between chromosome numbers and taxonomic grouping in different species and genera of woody plants. The plants investigated include species and genera in the Ulmaceae, Tiliaceae, and Cornaceae, as well as a number of rare or monotypic genera. A study of chromosome behavior in several genera of conifers by Mrs. Sax has provided information which may account for the morphological stability of this group of plants. A comparison of the chromosomes of *Yucca and Agave*, in collaboration with Mrs. McKelvey, proves

that these genera are closely related, even though they have been placed in different families by most taxonomists.

Cytological investigations of hybrids have thrown some light on the relationships of geographically distinct species, and have indicated the probable origin of the Pomoideae.

Several studies on the mechanism of chromosome pairing and division have been completed during the year. This work is a part of a general project involving an extensive study of the mechanism of heredity. Collaborators in this work include Dr. Anderson, Dr. Hally J. Sax, Mr. Dermen, Mr. King, and Mr. O'Mara.

During the past season more than 350 crosses have been made between different species and varieties of trees and shrubs. Relatively few crosses between distinct species are successful, but the species hybrids obtained should be of considerable interest. The breeding work has resulted in species hybrids of *Syringa*, *Lilium*, *Malus*, *Philadelphus*, *Ulmus*, *Lonicera*, *Ribes*, and *Rosa*. Numerous crosses were made between *Rosa rugosa* and other species, many of which were successful. This work was aided by a special contribution from a friend of the Arboretum.—K. S.

The Herbarium.—The Herbarium contains 358503 specimens, 10022 having been added between July 1, 1931 and June 30, 1932. Of the accessions approximately 2750 came from the United States and Canada, 1670 from Central and South America inclusive of Mexico, 390 from Europe and Western and Central Asia, 1400 from Eastern Asia and 375 from Southern Asia and Malaysia, 260 from Africa, 1250 from Australasia and 1200 represented cultivated plants.

Among the more important collections received during the year are the following: more than 1000 numbers with many duplicates collected by S. F. Kajewski in the Solomon Islands and about 250 collected by him in North Queensland, 400 specimens of Tasmanian plants purchased from the Tasmanian Museum, 750 Chinese plants collected in Kweichou by Y. Tsiang and 425 Chinese Plants collected in western China by J. F. Rock, 400 plants from northern Burma collected by F. Kingdon Ward, 600 numbers with duplicates collected in Sumatra by W. N. and C. M. Bangham, 160 Philippine plants collected by C. A. Wenzel, 260 Central African plants collected by J. Burtt Davy, 250 East African plants collected by H. Humbert, about 350 plants collected by G. Klug in Colombia (Putumayo River), 200 Brazilian plants from F. C. Hoehne, 520 Mexican plants from Stanford University, 220 numbers of Cuban plants with duplicates collected by J. G. Jack, and about 350 numbers of Yuccas with many duplicates collected by Mrs.

S. D. McKelvey, and with flowers and fruits in formaldehyde, cytological material, also insects pollinating the Yucca flowers.

The fruit collection numbers now 7439 specimens, 188 having been added during the year.

To the wood collection 83 specimens were added bringing the number up to 2365.

The collection of negatives of types and of other herbarium specimens consists now of 1857 negatives, 91 having been added during the year.

The installation of 16 new cases and 29 half-cases necessitated a rearrangement of the whole herbarium leaving space for accessions for a number of years. Besides constantly using the herbarium in the determination of plants sent in for identification and of some large collections chiefly from Eastern Asia and North America members of the staff have been engaged in special work; Dr. C. E. Kobuski has finished a revision of the Chinese species of *Jasminum* and Dr. Eva M. F. Roush is engaged in a similar revision of the genus *Eurya*, Dr. I. M. Johnston is continuing his work on the Boraginaceae, Mr. E. J. Palmer on the genus *Crataegus* and *Mr. A.* Rehder is continuing the revision of the ligneous plants described by H. Léveillé from Eastern Asia and the identification of collections of Chinese plants. Among visitors who have consulted the herbarium may be mentioned Dr. F. P. Metcalf of Lingnan University, Canton, China, Dr. E. D. Merrill of the New York Botanical Garden, Dr. S. F. Blake of the Department of Agriculture and Dr. R. E. Woodson of the Missouri Botanical Garden.

For study outside the Arboretum 931 specimens were sent on loan to institutions and individuals in this country and in Europe.

There have been distributed 22037 specimens to 40 institutions in the United States, Canada, Europe, Asia, Africa and Australia.

Botanical exploration by members of the staff or by expeditions partly financed by the Arnold Arboretum has been carried on in both Americas, Eastern Asia and Australia.

Mrs. Susan Delano McKelvey travelled from the middle of March to the end of May about 11000 miles in Texas, New Mexico, Arizona, California and Oklahoma for the purpose of studying and collecting *Yucca;* she obtained in addition to 350 herbarium specimens and 250 specimens of flowers and fruits in formaldehyde solution, about 100 numbers of chromosome material and 50 numbers of pollen smears, 125 numbers of entomological specimens including nearly 2000 Yucca moths and 100 excellent photographs.

Professor J. G. Jack spent the month of August 1931 and the months of February and March 1932 at the Harvard Tropical

Garden at Soledad, Cuba, and collected in the Garden and in the surrounding country about 4500 sheets of herbarium material besides wood specimens and seeds.

Mr. E. J. Palmer with Dr. Edgar Anderson collected during the month of April 1932 in the Atlantic coast region from New Jersey to Georgia, Mr. Palmer paying special attention to *Crataegus*.

Dr. H. M. Raup and Mr. E. C. Abbe started in June 1932 on a tour of botanical exploration of the Peace River region in the provinces of Alberta and British Columbia.

From March 1930 to May 1932 Mr. S. F. Kajewski has made extensive collections in the Solomon Islands and has collected more than 1000 numbers with numerous duplicates. Professor Albert N. Steward and Professor C. Y. Chiao of the University of Nanking undertook an expedition to the province of Kweichou from the end of June to November 1931 which proved very successful; an expedition to Kwangsi planned for 1932 had to be abandoned on account of the Sino-Japanese conflict in the spring of this year; it will probably take place next year. Professor H. H. Hu of the Fan Memorial Institute of Biology in Peiping sent his collector, Mr. F. T. Wang, to Szechuan during the summer of 1931 but owing to troubled conditions in that province the expedition was not quite as successful as was expected, though about 1000 numbers with duplicates were collected; this year the botanical exploration of Szechuan will be continued and probably extended into Yunnan. Mr. R. Goerz returned in August 1931 from his collecting tour into northeastern Asia Minor. G. Looser, a resident of Santiago, Chile, made a collecting tour in December 1931 to southern Coquimbo which is botanically almost unexplored.—A. R.

The Library.—Additions to the Library during the past year include 878 volumes, 205 pamphlets and 321 photographs, making a total of 40,648 bound volumes, 9,885 pamphlets and 16,786 photographs. Among the photographs are nearly 200 taken in the Arboretum during the spring and summer of 1931 by Mr. Herbert W. Gleason, about 100 taken by Mr. E. J. Palmer in the South and Middle West, 7 of the Bird Sanctuary at Lake Wales, Florida, including a large colored print of the Bok Singing Tower, the gift of Mrs. Edward Bok, 4 of Chinsegut Hill, Brooksville, Florida, the gift of Colonel and Mrs. Raymond Robins, and 80 post cards of "British trees published by the British Museum (Natural History)." To our collection of original drawings and water colors have been added by gift a beautiful water color of *Dendrobium Wardianum* by Mrs. Oakes Ames and an *Echeveria* by Miss M. A. Eaton, and by purchase 58 sheets of water color drawings recording with delicate

accuracy the many varieties of color and shading in Azaleas and Rhododendrons, by Mr. C. H. L. Gebfert.

Cards filed during the year include 1,200 in the Catalogue of books in the Library, 350 in the Catalogue of photographs, 5,446 in the "Card-index of New Genera, Species and Varieties published by the Gray Herbarium," and 3,827 in the manuscript "Index of Illustrations and of New Genera, Species and Varieties of Ligneous Plants published since 1915" prepared at the Arboretum.

In addition to the cards filed nearly 4,000 slips have been prepared and filed for the printed "Catalogue of the Library," which is now making satisfactory progress after a long delay due to unforseen circumstances.

Five hundred and seventy volumes, including periodicals, have been bound, while about 100 smaller books and pamphlets have been put into pamphlet binders.

The growth of the library and the increase in the number of persons using it have made necessary a large undertaking considered in former years unnecessary and disfiguring—placing book numbers on the back of the bindings. Much of this work has been done during the past year and has proved a great saving of time and effort as well as a means of locating books out of place, misplaced books being inevitable with shelves open to staff and visitors.

During the year a number of research workers have made use of the unusual facilities which the library affords, especially in Chinese literature. Dr. Franklin P. Metcalf of Lingnan University, Canton, China, left about the middle of September after nearly two years' study in the library and herbarium, preparing a Flora of Fukien. Dr. S. F. Blake of the United States Department of Agriculture spent some days examining the books on the floras of the world. Among other visitors using the library were Mr. Ahmed Hilmy, under the auspices of the Egyptian Legation, research workers from Arthur D. Little, Inc., and the United Fruit Company.

The number of new periodicals received during the year is rather larger than usual, many coming in exchange for the "Journal of the Arnold Arboretum," the "Arnold Arboretum Bulletin of Miscellaneous Information," "Contributions from the Arnold Arboretum of Harvard University," and for herbarium specimens, some by gift and a number by purchase. They are:

Acta phaenologica. Deel i, afl. 1 → 's-Gravenhage. 1931 →

Acta phytogeographica suecica. 1 → Uppsala. 1929 →

Acta phytotaxonomica et geobotanica. Vol. i, no. 1 → Kyoto. 1932 →

Annales sabarienses: folia musealia. i. Szombathely. 1932.

ARCHIVOS de botanica do estado de S. Paulo. Vol. i, fasc. 1 → São Paulo. 1925 →

AUCKLAND INSTITUTE AND MUSEUM. Records. Vol. i, no. 2. [Auckland.] 1931.

BLACK ROCK FOREST. Bulletin. No. 1 → Cornwall-on-the-Hudson. 1930 →

BUENOS AIRES—*Universidad.* Revista de la Facultad de agronomía y veterinaria. Tomo vii, entrega 1 → Buenos Aires. 1930 →

BUTANTAN, *Brazil—Instituto soroterapico.* Anexos das Memórias do Instituto de Butantan, Secção de botanica. Vol. i, fasc. 1–6. São Paulo. 1921–22.

CAVANILLESIA. Vol. i, fasc. 1 → Barcinone. 1928 →

CRACOW, *Poland—Universytet jagiellonski.* Publicationes Instituti botanici. Nr. 1–8. Cracovie, *etc.* 1931.

DIFESA delle piante contro le malattie ed i parassiti. Anno ix, n. 1–3. Torino. 1932.

GRAND CANYON nature notes. Vol. v, no. 6, 8–10, 12; vi, 1 → [Grand Canyon.] 1931–32 →

HARVARD UNIVERSITY—*Botanical museum.* Botanical museum leaflets. No. 1 → Cambridge. 1932 →

HONG KONG naturalist. Vol. i, no. 1 → Hong Kong. 1930 →

LEAFLETS of western botany. Vol. i, no. 1 → San Francisco. 1932 →

LYONS—*Société botanique.* Nouveau bulletin. Année i, no. 1–4. Lyon. 1913.

MESA VERDE notes. Vol. ii, no. 1 → [Mancos, Colo. 1931] →

NATURE. Vol. 129, no. 3244 → London. 1932 →

PHYSIS. Tomo i → Buenos Aires. 1912 →

SOCIEDADE BROTERIANA. Memorias. Vol. i → Coimbra. 1930 →

SOCIETÀ INTERNAZIONALE DI MICROBIOLOGIA—*Sezione italiana, Milan.* Bollettino. Vol. iv, fasc. 1 → Milan. [1932] →

SOUTH AFRICA—*Botanical survey.* Memoir 1 → Pretoria. 1919 →

SUIGEN, *Korea—Agricultural and forestry college.* Bulletin. No. 1–3. Suigen. 1925–28.

SYMBOLAE botanicae upsalienses. i → Uppsala. [1932] →

TAIHOKU IMPERIAL UNIVERSITY—*Herbarium.* Contributions. No. 1 → [Taihoku] 1930 →

UTRECHT—*Rijks universiteit—Botanisch museum en herbarium.* Mededeelingen. No. 1 → Amsterdam. 1932 →

Among other important accessions are:

KNIPHOF, J. H. Botanica in originali. 12 cent. (in 6 vol.). Halae Magdeburgicae. 1758 ['57]–64. 1200 hand-colored plates.

GRABOWSKI, H. E. Flora von Ober-Schlesien. Breslau. 1843.

[RIOCREUX, Alfred. Collection of 87 original drawings. 1860.]—Beautifully tooled green leather binding. Purchased from the income of the Mary Robeson Sargent fund.

THUNBERG, C. P. Nova genera plantarum. Upsaliae. [1781–1801.]

HU, H. H. Enumeration of plants in Chekiang. [Peiping. 1930?]—Gift of the author.

LEUDERS, P. E. Etwas vom coffee. [Glucksburg. 1784.]

VALLET, Pierre. Le jardin du roy tres chrestien Henry IV roy de France et de Navare. [Paris.] 1608. 73 plates before numbers.—Unbound, in half green morocco book-box.

AMMANN, Paul. Character plantarum naturalis, à fine ultimo videlicet fructificatione desumtus, ac præmisso fundamento methodi genuinæ cognoscendi plantas, per canones et exempla digestus. Francofurti; Lipsiæ, apud Nicol. Scipionem. 1685.

BATSCH, A. J. G. K. Versuch einer anleitung zur kenntniss und geschichte der pflanzen für academische vorlesungen entworfen und mit den nöthigsten abbildungen versehen. 2 theile. Halle. 1787–88. 11 plates.

M'MAHON, Bernard. A catalogue of garden, grass, herb, flower, tree & shrub-seeds, flower-roots, & sold by Bernard M'Mahon, seedsman. [Philadelphia? 1800?]—A photostatic copy of one of the oldest American nursery catalogues. Gift of Mr. E. C. Vick.

[AMES, Oakes. Original manuscript of new species, "New combinations and additions to the orchid flora of the Philippines," prepared for fasc. v of his "Orchidaceae" in 1914–15.]—Gift of the author.

MUELLER, Johann Sebastian (afterwards John MILLER). Illustratio systematis sexualis Linnæi. London. 1777 ['70–77]. f°. 104 plates, and engraved title-page. (4 colored plates inserted.)

———— Another copy of the 104 plates, colored by hand, without title or text.

LINK, H. F. Icones plantarum selectarum Horti regii botanici berolinensis. Auctoribus H. F. Link et F. Otto. Fasc. i–x (in 1 vol.). Berolini. 1820–28. 60 colored plates.

MORICAND, Stephano. Plantae americanæ rariores. Genève. 1830. 10 plates.

SCHLEICHER, J. C. Catalogus plantarum in Helvetia cis-et transalpina sponte nascentium. Bex. [1800.]

———— *The same.* [Bex.] 1807.

VALMONT DE BOMARE. Dictionnaire raisonné universel d'histoire naturelle. 5 tom. Paris. 1764.

REICHENBACH, H. G. L. Repertorium herbarii. Dresdae et Lipsiae. 1841. (Der deutscher botaniker, 1.)

FUCHS, Remacleus. Plantarum omnium, quarum hodie apud pharmacopolas usus est magis frequens nomenclaturæ juxta grecorum, latinorũ, gallo., italorũ, hispa & germa. sententiam. Parisiis. 1541.—Very rare, first edition of the first botanical work by the first Belgic writer. Purchased from the income of the Mary Robeson Sargent fund.

RINALDI, Giovanni de. Il mostruosissimo mostro, nel secundo si tratta dell'herbe, & fiori.—Pritzel 7634: "Liber rarissimus." Apparently first and unique edition. The second part of this peculiar work is of botanical interest and treats of the symbolic signification of flowers in old literature. An early dictionary of language of flowers—a most curious and uncommon tract, also of folkloristical interest. This little work is very scarce. Gift of Mrs. Sarah C. Sears.

EHRHART, Balthasar. Oekonomische pflanzenhistoire. 2^{e} verbesserte aufl. 12 teile (in 4 vol.). Ulm und Mèmmingen. 1756, '53-62.

MÖLLENDORFF, P. G. & O. F. Manual of Chinese bibliography; being a list of works and essays relating to China. Shanghai. 1876.

CORRÊA, Pio. Diccionario das plantas uteis do Brasil e das exoticas cultivadas. Vol. i, ii. Rio de Janeiro. 1926–31. Illustr.

[BRUNFELS, Otto.] In Dioscoridis historiam herbarum certissima adaptatio. Argentorati. 1543. Wdcts.—Extremely rare edition. A contemporary ownership note on the fly-leaf states that this belonged to Giustiniani Paoluccelli, that it was bought at Venice, and bound at Padua in 1545.

SASAKI, Syun'iti. A catalogue of the government herbarium. Taihoku. 1930. (Formosa—Department of forestry.)

WILSON, H. W., COMPANY. Union list of serials in libraries of the United States and Canada. Supplement. Jan. 1925–June, 1931. New York. 1931.

A large number of books were sent out as inter-library loans to Arthur D. Little, Inc., Marine Biological Laboratory, Bussey Institution of Applied Biology, Yale University, Massachusetts Institute of Technology, Harvard Forest, Harvard College, Harvard Medical School, University of Minnesota, New York State College of Agriculture, United States Department of Agriculture, Massachusetts Horticultural Society, Gray Herbarium, Lowthorpe School,

Ohio State University, Laselle Seminary, Smith College, Olmsted Brothers, University of New Hampshire, Massachusetts Agricultural College, Canada Department of Mines, Harvard Museum of Comparative Zoology and other institutions. Sixty seven photographs were loaned to the Royal Horticultural Society for the Conifer conference of 1931. A few books were borrowed.

The library has been fortunate in being able to make up from odd numbers and oversheets, with the aid of a few photostatic reproductions, several copies of the "Silva of North America" by C. S. Sargent. With the exception of one copy these have been sold. At the same time several complete sets of the plates were made in Paris, and may be purchased from the library. They would make a valuable addition to any botanical library or herbarium.

The library has also sold 1,972 photographs taken by the late Dr. E. H. Wilson in China, Japan, Australasia, India and Africa, and many other photographs.—E. M. T.

Bibliography of the published writings of the staff and students July 1, 1931–June 30, 1932

ABBE, Ernst C.

Chromosome numbers and the anatomy of the secondary xylem in the Oleaceae. [By] Karl Sax and Ernst C. Abbe. (In *Journal of the Arnold arboretum*, 1932, xiii, 37–48.)

AMES, Oakes.

The Arnold arboretum; [report 1930–31]. (In *Journal of the Arnold arboretum*, 1931, xii, 296–297.)

Juniperus virginiana growing on a rock. (In *Arnold arboretum bulletin of popular information*, 1931, v, 62–64.)

Orchidaceae [of the Tyler-Duida expedition]. By Oakes Ames and Charles Schweinfurth. (In *Bulletin of the Torrey botanical club*, 1931, lviii, 345–353.)

Additions to the orchid flora of the United States. (In *Proceedings of the Biological society of Washington*, 1932, xlv, 3–4.)

Contributions to the flora of the New Hebrides and Santa Cruz Islands; orchids collected by S. F. Kajewski in 1928 and 1929. (In *Journal of the Arnold arboretum*, 1932, xiii, 127–141.)

A new Bletia from Honduras. (In *Proceedings of the Biological society of Washington*, 1932, xlv, 1–2.)

A new Epidendrum from Spanish Honduras. (In *Harvard university, Botanical museum leaflets*, 1932, no. 2, pp. 1–3.)

A new genus of the Orchidaceae from the New Hebrides. (In *Journal of the Arnold arboretum*, 1932, xiii, 142–144.)

New or noteworthy Philippine orchids. ii. By Oakes Ames and Eduardo Quisumbing. (In *Philippine journal of science*, 1932, xlvii, 197–220.)

Two new orchids from Yucatan and Trinidad. By Oakes Ames and Charles Schweinfurth. (In *Harvard university, Botanical museum leaflets*, 1932, no. 2, pp. 4–7.)

ANDERSON, Edgar.

The art of budding. By Edgar Anderson and W. H. Judd. (In *Arnold arboretum bulletin of popular information*, 1931, v. 49–52.)

The chromosome complements of Allium stellatum and Nothoscordum bivalve. (In *Annals of the Missouri botanical garden*, 1931, xviii, 465–468.)

Hybrid trees. (In *Arnold arboretum bulletin of popular information*, 1931, v, 65–68.)

Species hybrids in Aquilegia. By Edgar Anderson and Brenhilda Schafer. (In *Annals of botany*, 1931, xlv, 639–646.)

Baltic ivy. (In *Arnold arboretum bulletin of popular information*, 1932, vi, 1–6.)

Character recombination in Drosophila. (In *Proceedings of the National academy of sciences*, 1932, xviii, 427–429.)

Contributions to the Tradescantia problem. By Edgar Anderson and D. G. Diehl. (In *Journal of the Arnold arboretum*, 1932, xiii, 213–231.)

Fire! (In *Arnold arboretum bulletin of popular information*, 1932, vi, 21–24.)

How big is a cell? (In *Science*, 1932, lxxv, 359.)

Rosa rugosa and its hybrids. By Edgar Anderson and W. H. Judd. (In *Arnold arboretum bulletin of popular information*, 1932, vi, 29–35.)

BENNETT, Elizabeth Dean.

Arboreta and botanic gardens in the United States. (In *Arnold arboretum bulletin of popular information*, 1931, v, 53–60.)

Bibliography of the published writings of the staff and students [of the Arnold arboretum], July 1, 1930–June 30, 1931. (In *Journal of the Arnold arboretum*, 1931, xii, 305–307.)

CHESTER, Kenneth Starr.

Lilac graft-blight and its relation to water deficiency in woody plants. (In *Proceedings of the National shade tree conference*, 1931, pp. 92–97.)

A comparative study of three Phytophthora diseases of lilac and of their pathogens. (In *Journal of the Arnold arboretum*, 1932, xiii, 232–269.)

Studies on the precipitin reaction in plants. i, ii. (In *Journal of the Arnold arboretum*, 1932, xiii, 52–74, 285–296.)

CURRIE, Mary L.

Parasitism of Myxomycete plasmodia on the sporophores of Hymenomycetes. By F. L. Howard and Mary E. Currie. (In *Journal of the Arnold arboretum*, 1932, xiii, 270–284.)

DARKER, Grant Dooks.

The Hypodermataceae of conifers. (In *Contributions from the Arnold arboretum of Harvard university*, 1932, no. 1.)

DERMEN, Haig.

A study of the chromosome number in two genera of Berberidaceae: Mahonia and Berberis. (In *Journal of the Arnold arboretum*, 1931, xii, 281–287.)

Chromosome numbers in the genus Tilia. (In *Journal of the Arnold arboretum*, 1932, xiii, 49–51.)

DIEHL, Douglas George.

Contributions to the Tradescantia problem. By Edgar Anderson and D. G. Diehl. (In *Journal of the Arnold arboretum*, 1932, xiii, 213–231.)

EHRLICH, John.

Forest pathology in Nova Scotia. (In *Report of the Department of lands and forests, Province of Nova Scotia*, for 1931, pp. 36–45.)

Areolate mildew of cotton. [By] John Ehrlich and F. A. Wolf. (In *Phytopathology*, 1932, xxii, 229–240.)

The occurrence in the United States of Cryptococcus fagi (*Baer*) *Dougl.*, the insect factor, in a menacing disease of beech. (In *Journal of the Arnold arboretum*, 1932, xiii, 75–80.)

FAULL, Joseph Horace.

Arnold arboretum Pathological laboratory; [report 1930–31]. (In *Journal of the Arnold arboretum*, 1931, xii, 297–299.)

Milesina rusts on Aspidium Braunii *Spenner*. (In *Journal of the Arnold arboretum*, 1931, xii, 218–219.)

An outline of forest pathology [by E. E. Hubert. Review]. (In *Phytopathology*, 1932, xxii, 393–395.)

"Winter browning" of conifers. (In *Arnold arboretum bulletin of popular information*, 1932, vi. 8.)

HOWARD, Frank L.

Parasitism of Myxomycete plasmodia on the sporophores of Hymenomycetes. [By] F. L. Howard and Mary E. Currie. (In *Journal of the Arnold arboretum*, 1932, xiii, 270–284.)

JACK, John George.

The Cambridge Washington elm. (In *Arnold arboretum bulletin of popular information*, 1931, v, 69–73.)

Late summer flowering trees. (In *Arnold arboretum bulletin of popular information*, 1931, v, 45–48.)

Transplanting spruces and yews. (In *Arnold arboretum bulletin of popular information*, 1931, v, 61–62.)

Cherries and peaches. (In *Arnold arboretum bulletin of popular information*, 1932, vi, 17–18.)

Hawthorns. (In *Arnold arboretum bulletin of popular information*, 1932, vi, 25–28.)

Juneberries. (In *Arnold arboretum bulletin of popular information*, 1932, vi, 18–20.)

Some early flowering trees. (In *Arnold arboretum bulletin of popular information*, 1932, vi, 9–14.)

JOHNSTON, Ivan Murray.

The flora of the Revillagigedo Islands. (In *Proceedings of the California academy of sciences*, 1931, xx, 9–104.)

New spermatophytes from Mexico and Argentina. (In *Contributions from the Gray herbarium*, 1931, xcv, 53–55.)

Vascular flora of the guano islands of Peru. (In *Contributions from the Gray herbarium*, 1931, xcv, 26–35.)

JUDD, William Henry.

E. H. Wilson. (In *Journal of the Kew guild*, 1931, v, 79–81.)

Robinia Hartwigii. (In *Gardeners' chronicle*, 1931, xc, 469.)

The art of budding. By Edgar Anderson and W. H. Judd. (In *Arnold arboretum bulletin of popular information*, 1932, v, 49–52.)

Broad-leaved evergreens for garden decoration. (In *Horticulture*, 1932, x, 67–68.)

Lobelia cardinalis. (In *Gardeners' chronicle*, 1932, xci, 201.)

Prunus subhirtella var. autumnalis. (In *Gardeners' chronicle*, 1932, xci, 362.)

Rosa rugosa and its hybrids. By Edgar Anderson and W. H. Judd. (In *Arnold arboretum bulletin of popular information*, 1932, vi, 29–35.)

KOBUSKI, Clarence Emmeren.

Synopsis of the Chinese species of Jasminum. (In *Journal of the Arnold arboretum*, 1932, xiii, 145–179.)

O'MARA, Joseph.

Chromosome pairing in Yucca flaccida. (In *Cytologia*, 1931, iii, 66–76.)

PALMER, Ernest Jesse.

A conspectus of the genus Amorpha. (In *Journal of the Arnold arboretum*, 1931, xii, 157–197.)

Notes on Ophioglossum Engelmanni. (In *American fern journal*, 1932, xxii, 43–47.)

REHDER, Alfred.

Rhododendron minutiflorum. (In *Rhododendron society notes*, 1929–31, iii, 283.)

Arnold arboretum Herbarium; [report 1930–31]. (In *Journal of the Arnold arboretum*, 1931, xii, 299–302.)

Notes on the ligneous plants described by H. Léveillé from eastern Asia. (In *Journal of the Arnold arboretum*, 1931, xii, 275–281.)

A silvicultural study of Abies pinsapo. [Review of A. Barbey's "À travers les forêts de Pinsapo d'Andalousie."] (In *Journal of the Arnold arboretum*, 1931, xii, 219–220.)

Zur geschichte der gehölzeinführungen nach Nordamerika. (In *Mitteilungen der Deutschen dendrologischen gesellschaft*, 1932, nr. 44, pp. 114–122.

Kalmiopsis, a new genus of Ericaceae from northwest America. (In *Journal of the Arnold arboretum*, 1932, xiii, 30–34.)

Nomenclatorial notes on plants growing in the botanical garden of the Atkins institution of the Arnold arboretum at Soledad, Cienfuegos, Cuba. By F. T. Hubbard and Alfred Rehder. (In *Harvard university, Botanical museum leaflets*, 1932, no. 1, pp. 1–11.)

Sax, Karl.

Arnold arboretum Cytology laboratory; [report 1930–31]. (In *Journal of the Arnold arboretum*, 1931, xii, 299.)

Chromosome numbers in the ligneous Saxifragaceae. (In *Journal of the Arnold arboretum*, 1931, xii, 198–206.)

Chromosome ring formation in Rhoeo discolor. (In *Cytologia*, 1931, iii, 36–53.)

Crossing-over and mutation. (In *Proceedings of the National academy of sciences*, 1931, xvii, 601–603.)

The smear technique in plant cytology. (In *Stain technology*, 1931, vi, 117–122.)

Chromosome numbers and the anatomy of the secondary xylem in the Oleaceae. [By] Karl Sax and Ernst C. Abbe. (In *Journal of the Arnold arboretum*, 1932, xiii, 37–48.)

The cytological mechanism of crossing over. (In *Journal of the Arnold arboretum*, 1932, xiii, 180–212.)

Flowering habits of trees and shrubs. (In *Arnold arboretum bulletin of popular information*, 1932, vi, 14–16.)

Tucker, Ethelyn Maria.

Arnold arboretum Library; [report 1930–31]. (In *Journal of the Arnold arboretum*, 1931, xii, 302–305.)

The above articles cover a total of about 615 pages.

K. E. K.

Staff of the Arnold Arboretum, 1932–33

Oakes Ames, A.M., Arnold Professor of Botany, Supervisor.
John George Jack, Assistant Professor of Dendrology.
Alfred Rehder, A.M., Curator of the Herbarium.
Joseph H. Faull, Ph.D., Professor of Forest Pathology.
Irving Widmer Bailey, S.D., Professor of Plant Anatomy.
Karl Sax, Ph.D., Associate Professor of Cytology.
Edgar Anderson, S.D., Arborist.
Ivan Murray Johnston, Ph.D., Research Associate.
Clarence E. Kobuski, Ph.D., Assistant Curator, Herbarium.
Ernest J. Palmer, Collector and Research Assistant.
Eva M. Fling Roush, Ph.D., Assistant in the Herbarium.
Kenneth S. Chester, Ph.D., Research Assistant, Phytopathology.
Grant D. Darker, Ph.D., Assistant in Phytopathology.
Haig Dermen, M.S., Research Assistant.
Ivan H. Crowell. A.M., Assistant in Phytopathology.
Hugh M. Raup, Ph.D., Research Assistant.
Ethelyn Maria Tucker, Librarian.
Susan Delano McKelvey, A.B., Research Assistant.
Ethel Antoinette Anderson, Business Secretary.
Katharine Eleanor Kelley, Assistant in the Library.
Louis Victor Schmitt, Superintendent.
William Henry Judd, Propagator.

ERRATA AND ADDENDA

Page 31, line 22 *for* relict *read* relic

" " line 18 from below *for* relicts *read* relics

" 75, line 8 *for* Sporadically *read* Sporadical

" 83, line 3 from below *for* **Hedycarya** *read* **Hedycaria**

" 112, line 2 from below *for* CHAMBEYRENIA *read* CHAMBEYRONIA

" 156, line 17 insert under **Jasminum lanceolarium** Roxb.:

Fagara volubilis E. Pritzel in Bot. Jahrb. XXIX. 422 (1900).—**Syn. nov.**

Zanthoxylum volubilis (Pritz.) Chung in Mem, Sci. Soc. China, I. 124 (1924).—**Syn. nov.**

S z e c h u a n: Nanchuan, Kinshan, *Bock & Rosthorn*, no. 19, July 1891 (Herb. Oslo and Berlin; photo. in A. A.).[1]

" 157, line 1 *for* 6954 *read* 6964

" 158, after line 11 from below insert under **Jasminum lanceolarium** var. **puberulum:**

Fagara volubilis E. Pritzel var. *pubescens* Pampanini in Nuov. Giorn. Bot. Ital. n. s. XVII. 406 (1910).—**Syn. nov.**

H u p e h: Monte "Triora," alt. 1950 m., *C. Silvestri*, nos. 1221 and 1221a, Sept. 1907 (Herb. Biondi, Florence; photo. in A. A.).

" 195, line 10 from below *for* In *read* If

" 302, line 6 *for* 1928 *read* 1898

" 329, line 5 from below *for* 1351 *read* 1531

[1] When examining recently the types of Pampanini's new species and varieties of Chinese plants in the Erbario Biondi at Florence, I found that the plant described as *Fagara volubilis* var. *pubescens* and represented by a fruiting specimen belongs to *Jasminum lanceolarium* Roxb. var. *puberulum* Hemsl. This led me to examine typical *Fagara volubilis* E. Pritz. of which there is in the Arnold Arboretum herbarium a photograph of the type specimen, taken by me in the herbarium of the Botanic Garden in Oslo. The photograph shows clearly that this plant too is not a *Fagara*, but is identical with *Jasminum lanceolarium* Roxb. which was collected later in the same locality by W. P. Fang. Also Pritzel's description fits *Jasminum lanceolarium*. Therefore, both *Fagara volubilis* E. Pritz. and *Fagara volubilis* var. *pubescens* Pampan. become synonyms of *Jasminum lanceolarium* Roxb. and its variety.—A. Rehder.

INDEX

Synonyms are printed in *italics;* new names in **bold-face** type.